U. S. COAST GUARD GUIDE FOR THE MANAGEMENT OF CREW ENDURANCE RISK FACTORS

Version 1.1

U.S. Coast Guard Research & Development Center

U.S. Coast Guard Research and Development Center
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Marc B. Mandler, Ph.D.
Technical Director
United States Coast Guard
Research & Development Center
1082 Shennecossett Road
Groton, CT 06340-6096

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A ship's endurance depends on how long it can support operations at sea without replenishing supplies or requiring in-port maintenance. Similarly, crew endurance can be described as a function of physiological and psychological factors that support crew members' ability to perform their jobs effectively. Recent studies of Coast Guard personnel on cutters, at small boat stations, and at air stations have shown that some of our traditional work practices can lead to poor endurance, which translates to poor readiness. This *Guide* will show you how to manage crew endurance. It explains the different endurance risk factors and takes you step-by-step through the process of identifying these risks at your unit and implementing the controls necessary to improve crew endurance and mission effectiveness. These practical methods have been tested and proven on Coast Guard cutters, at Coast Guard air stations, at small boat stations, and on commercial vessels.

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FOREWORD

We all recognize that Coast Guard personnel endure challenging work environments that can compromise alertness and performance. Long work hours, harsh working conditions, extreme temperatures, frequent separation from loved ones and fatigue are all too familiar demands that our people encounter on a regular basis. Despite the steadfast dedication and motivation our people have for the mission, exposure to these factors may compromise crew endurance, increase operational risk, and reduce mission readiness. As we confront current challenges, and prepare for new opportunities that technology and operational demands will bring, we must acknowledge that the protection of our people remains our highest priority and do our best to ensure that crew endurance limits are not exceeded. This *Guide* will help you understand what crew endurance risk is, recognize the factors that compromise endurance, and develop strategies to manage and control crew endurance risk.

The information offered in the *Guide* was developed specifically for, and tested on, Coast Guard assets. A number of operational units are currently using the *Guide* to control crew endurance risk and improve operational readiness. It is an easy to read, step-by-step tool for identifying and managing crew endurance risk. The "Risk Assessment" section provides an objective and simple method of identifying crew endurance risk factors. If risk is identified, it guides you to information on how to manage the risk. The "Controls" section provides concise information on a variety of issues (e.g., sleep, caffeine, stress, motion sickness, etc.) that can compromise endurance. This information is ideal for all-hands and safety stand-down meetings to educate our people on how crew endurance risk factors degrade work as well as personal health, safety, and well-being. The "Implementation" section provides a step-by-step process to institute and test crew endurance management efforts.

Responsibility for managing crew endurance risk factors is shared at three distinct levels; the Coast Guard, the command, and the individual. The Coast Guard, at the Service level, develops policy and sets standards of performance. Our increasing knowledge of crew endurance risk factors will be incorporated as we review existing and develop new policies and standards. The Coast Guard has developed this *Guide*, and will continue to update and refine the guidance it provides. Commands transform policies and standards into action. Commands shall read and apply the information in the *Guide*. It provides information needed to protect our most valuable asset, our people, and shall be used to predict and plan proactively to prevent crew endurance risk factors that can compromise operational readiness. The individual Coast Guard crew member is the final critical link to mitigating risk factors. Every crew member must assume individual responsibility to develop and comply with a personal endurance plan to ensure they are ready and able to stand the watch.

The *Guide* provides the tools you need to manage crew endurance risk factors, but it will only help if it is employed as part of the daily operational planning process.

Use it! It works!

Rear Admiral Terry M. Cross
Assistant Commandant for Operations

EXECUTIVE SUMMARY

Crew endurance is more than just "fatigue." It encompasses many different physiological and psychological factors, such as the quality and duration of sleep; the stability of the person's body clock; environmental stressors, such as heat, cold, noise, and ship motion; emotional states and stress levels; diet; and physical conditioning. Just as a ship's endurance determines how long it can support operations at sea, crew endurance determines how effectively personnel can do their jobs.

According to the National Sleep Foundation's 2001 Sleep in America Poll, 63% of adult Americans do not get 8 hours of sleep per night – the required amount of sleep for good health, safety, and optimum performance. The majority of our operational personnel also gets insufficient sleep. Recent studies of Coast Guard (CG) crews on cutters, at small boat stations, and at air stations have shown that some of our traditional work practices may lead to decreased alertness that could compromise readiness: *70% of the CG personnel studied exhibited signs of compromised alertness.* While we might like to believe that we can be *Semper Paratus* under any conditions, this simply is not the case: long work hours, frequent schedule rotations, insufficient sleep, and extreme environmental conditions take their toll on the human body, leaving even Coast Guard personnel less-than-ready for duty. If we are to be *"always ready"* we must make crew endurance a top priority. If your unit experiences any of the following, you are at risk for compromised endurance and readiness:

- insufficient sleep duration (< 7-8 hrs.);
- poor sleep quality (awakenings);
- breaking sleep into multiple "naps;"
- main sleep during the daytime;
- rotating between day and night work;
- long work hours (>12 hr.);
- no opportunities to make up lost sleep;
- poor diet (high fat, sugar, caffeine);
- high workload;
- high stress;
- lack of control over work environment or decisions;
- exposure to extreme environment (cold, heat, high seas);
- no opportunity to exercise;
- family stress (child and parent care, divorce, finances);
- isolation from family.

The good news is that *crew endurance can be managed*. Through research studies on CG cutters, at small boat stations, and at air stations, we have developed practical, proven methods to identify and manage crew endurance risks that could compromise the safety and effectiveness of Coast Guard operations. This *Guide* will take you step-by-step through the process of understanding what endurance is, identifying endurance risk factors in your operation, exploring unit and personal options, and successfully implementing changes that will improve endurance *and* increase mission effectiveness. The methods discussed in this *Guide* go well beyond scientific theory. These are practical, workable methods to improve crew endurance that have been successfully implemented and proven on Coast

Guard cutters, at Coast Guard air stations, at small boat stations, and on commercial vessels. In short: ***this works.***

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1 OVERVIEW OF THE *U.S. COAST GUARD GUIDE TO MANAGING CREW ENDURANCE RISK FACTORS*

1.1 Introduction

Sleep-related problems are widespread in America. According to the National Sleep Foundation's 2001 Sleep in America Poll, 63% of adult Americans do not get 8 hours of sleep per night – the required amount of sleep for good health, safety, and optimum performance. More than 80% of the respondents indicated that they would change their sleep habits if they could be healthier, avoid injuries, or improve their memory. Little do they realize that getting sufficient, good-quality sleep can do all these things! The majority of the U.S. Coast Guard operational community also gets insufficient sleep. By getting better sleep and taking other steps to improve crew endurance, the Coast Guard and its personnel can reap improved health, performance, and mission effectiveness.

Recent studies of Coast Guard (CG) crews on cutters, at small boat stations, and at air stations, have shown that some of our traditional work practices may lead to decreases in crew alertness that could compromise readiness: *70% of the CG personnel studied exhibited signs of compromised alertness.* While we might like to believe that we can be *Semper Paratus* under any conditions, this simply is not the case: long work hours, insufficient sleep, and extreme environmental conditions take their toll on the human body, leaving even Coast Guard personnel less-than-ready for duty. If we are to be *"always ready"* we must make crew endurance a top priority. This *Guide* provides step-by-step instructions to identify and manage crew endurance risk in CG operations.

If your unit experiences any of the following, you are at risk for compromised endurance and readiness:

- insufficient sleep duration (< 7-8 hrs.);
- poor sleep quality (awakenings);
- breaking sleep into multiple "naps;"
- main sleep during the daytime;
- rotating between day and night work;
- long work hours (>12 hr.);
- no opportunities to make up lost sleep;
- poor diet (high fat, sugar, caffeine);
- high workload;
- high stress;
- lack of control over work environment or decisions;
- exposure to extreme environment (cold, heat, high seas);
- no opportunity to exercise;

- family stress (child and parent care, divorce, finances);
- isolation from family.

Crew endurance ***can be managed*** – and this *Guide* will show you how. This *Guide* describes specific elements (crew endurance risk assessment and risk management) of a Crew Endurance Management (CEM) program being developed at the Coast Guard Research and Development Center. While the CEM program is not fully developed, the elements in this *Guide* can have immediate benefit to the operational community and warrant early release. As other elements of the CEM program become available, they will be incorporated into the *Guide*. The information in the *Guide* is derived from a number of Coast Guard operations (afloat, air and shore); however, the examples used are from the cutter community where we have the most detailed data to date. We are compiling specific guidance for the small boat, aviation, and shoreside communities, and these will be incorporated into future versions of the *Guide*.

1.2 What Is Crew Endurance?

A ship's endurance depends on how long it can support operations at sea without replenishing supplies or requiring in-port maintenance. Similarly, crew endurance can be described as a function of physiological and psychological factors that support the crew member's ability to perform his/her job effectively. At the individual level, ***safety depends on endurance***.

Crew endurance refers to the ability to maintain performance within safety limits while enduring job-related physiological and psychological challenges.

"Crew endurance" is more than just "fatigue." Some of the physiological and psychological factors which affect crew endurance include:

- quality and duration of sleep,
- stability of the person's biological clock (the body's internal timing system),
- the internal state of the person (e.g., emotional state, stress level),
- environmental stressors (such as heat, cold, noise, and ship motion),
- diet, and
- physical conditioning.

These factors all exert a direct influence on the person's energy levels, alertness, and performance. When these factors are chronically outside of optimal human ranges, they become crew endurance risks or hazards and must be controlled. This *Guide* provides step-by-step instruction to identify and manage crew endurance risk in CG operations.

PURPOSE OF THIS GUIDE

This *Guide* provides the leader with proven "how to" methods to implement controls for crew endurance risks that threaten the safety of operations in the Coast Guard.

1.3 How to Use This Guide

Important concepts have been highlighted in boxes. It is recommended that the reader first review the Guide by reading all the information in the boxes. Doing so will help the reader understand how the Guide is structured and give the reader a preview of the useful information to be discussed. The boxes will also make it easy for the reader to refer back to these important concepts and their explanations and to assist in developing a better understanding of the main ideas of crew endurance management. Also of interest are the "Management Nuggets," which are suggestions that leaders can use to make immediate improvements in crew endurance.

Section 2 introduces the three phases of crew endurance management and guides the reader through a *Crew Endurance Risk Assessment* of their unit. It then goes on to describe briefly the different levels at which controls can be identified and implemented.

Section 3 provides information that will help the reader become more familiar with the harmful effects of endurance risk factors, such as stress, fatigue, and unpredictable work schedules, on crew members' performance. Section 3 also provides specific recommendations on how to control crew endurance hazards. It is recommended that pertinent parts of Section 3 be distributed to all personnel in your unit as a way to educate everyone on crew endurance hazards and our individual responsibilities to control risk.

Section 4 provides detailed guidance on how to design and implement a crew endurance plan. It describes in detail the three steps of: identifying hazards within current operations; developing and implementing a crew endurance plan; and evaluating the effectiveness of the crew endurance plan. Additional details on topics such as sleep cycles and special schedule considerations for personnel on the night watch can be found in the Appendices.

2 CREW ENDURANCE RISK ASSESSMENT

2.1 Overview of Section 2

In Section 2 you will:

- learn the three phases of managing crew endurance;
- identify and prioritize crew endurance risk factors relevant to your unit;
- get an overview of how to develop, implement, and evaluate a crew endurance plan for your unit.

2.2 The Three Phases of Crew Endurance Management (CEM)

There are three phases for the successful management of crew endurance at your unit:

Phase I: Initial Evaluation
- Form a crew endurance Working Group
- Conduct a crew endurance risk assessment
- Measure crew endurance under your current operations
- Develop a plan to control crew endurance risk factors

Phase II: Implementation
- Implement the crew endurance plan

Phase III: Follow-up Evaluation
- Evaluate the effectiveness of the crew endurance plan
- Periodic reassessment and continuing education

The Phase I evaluation is aimed at: identifying the crew endurance risk factors relevant to your unit, and understanding how your unit's policies and operational environment contribute to these risks. With this knowledge, the Working Group can devise alternative strategies to improve endurance. In Phase II these strategies are implemented, followed by a formal evaluation and periodic education and reassessments in Phase III.

2.3 Phase I – Initial Evaluation

2.3.1 Forming A Crew Endurance Working Group

The Working Group is the "cornerstone" to a successful crew endurance management program. The Working Group is empowered and supported by the organization to identify and manage crew endurance risk. The Working Group approach is successful because it brings together people with different experiences and sensitivities to the variety and complexity of CG operations, and offers members an opportunity to share their concerns about endurance and fatigue. The Working Group process also builds ownership in the crew endurance management program and facilitates implementing change to current operations. The Working Group should be composed of representatives from the different departments at the unit and workforce. Although one person might be able to make a good "first cut" at assessing current risk factors and developing a crew endurance plan, it is unlikely that any one person will be aware of all the different endurance risks that challenge each and every department or group within the unit. As a case in point, managers were asked to identify risks their personnel faced. Then, in a separate session, personnel were asked to identify risks they face. There were striking differences between how the managers and the personnel assessed the risks. This underscores the need for a Working Group. By having representatives from each major group or function within the unit, the Working Group will be able to provide a more complete assessment of the unit's crew endurance risks, which in turn will lead to a better and more workable crew endurance plan.

If your unit is very small, or if resources are not available to allow the Working Group concept, a single individual can certainly identify many of the unit's risk factors and develop workable solutions. In the case of a "Working Group of one," it is highly recommended that this person hold informal discussions with other members at the unit to ensure that the most important risk factors are identified and to get feedback on potential problems of endurance plan ideas before implementing them.

All members of the crew endurance Working Group need to be ***educated*** on crew endurance and the process for developing and implementing a crew endurance plan. This *Guide* was developed to contain everything you need for this basic education. ***Each Working Group member should read:***

- all of Section 1 (Overview)
- all of Section 2 (this section--Crew Endurance Risk Assessment)
- at a minimum, relevant parts of Section 3 (Crew Endurance Hazards and Controls) based on the results of the crew endurance risk assessment; it is recommended that Working Group members read Section 3 in its entirety, so as not to inadvertently cause new risks by solving existing ones.
- all of Section 4 (Putting It Altogether)

2.3.2 Conducting A Crew Endurance Risk Assessment For Your Unit

Crew endurance risk factors contribute to high levels of fatigue and compromise readiness, causing a deterioration of crew members' ability to perform their duties. Studies by the CG Research & Development Center (R&DC) have identified a list of crew endurance risk factors, common in many Coast Guard units, that present mental and physical challenges to personnel and threaten their ability to maintain performance within safety limits (i.e., threatens crew endurance). Any of these risk factors can erode crew endurance and readiness. Units that frequently exhibit any of these risk factors compromise readiness and their personnel. These risk factors have been compiled into an easy-to-use rating form to conduct crew endurance risk assessments. The Crew Endurance Risk Assessment Form is presented on the next page. This form is used to identify crew endurance risk factors and assess how frequently they occur at your unit. In addition, for each risk factor, appropriate sections of the *Guide* are referenced (bold text) where the reader can get information on how/why the endurance risk occurs and ways to manage/control the risk.

The Working Group conducts the ***crew endurance risk assessment***. Using the Crew Endurance Risk Assessment Form, each member of the working group identifies the risk factors they believe exist at the unit.

If a risk factor is present,

1. check-off the box next to the risk factor on the form, and
2. on a scale of 1-7, rate how often the risk occurs per week (e.g., if it occurs once per week, put "1" in the space provided.

If your unit experiences different operational requirements that may compromise endurance, it is recommended that the Working Group do a risk assessment for each of the different missions or different operations. For example, some units have a hectic summer search and rescue (SAR) season which strains crew endurance to a much greater degree than the winter season. Cutter crews may experience different crew endurance risks at sea as compared with in port.

When the Group completes a rating, the member ratings can be totaled to get the Working Group's average responses to each risk factor. Plotting these sums (or averages) as a bar chart gives a visual appreciation for your exposure to the risk factors. Figure 2-1 shows hypothetical data for a cutter crew during extended underway law enforcement (LE) missions (Fig. 2-1A) and for the same crew while in port (Fig. 2-1B). The requirements of the law enforcement mission will likely put the crew under a different set of watch schedules, operational activities, and other stressors (such as reducing the frequency of communication with family or increasing exposure to extreme environmental conditions), compared with the in-port scenario. These in turn may produce different crew endurance risks. Studying the effects of different operational scenarios and tempos on the Deck, Operations, Engineering, and Support departments will help to identify the types of endurance risks to which the crew are subjected and when they are most likely to occur. The plots make it easy to see not only how exposure to risk factors may vary depending on operating conditions, but how to allocate resources to manage the risk.

Using these plots, the Working Group begins to discuss and explore the circumstances that expose the unit to the risk factors. The Working Group should consider the following questions for each risk factor identified:

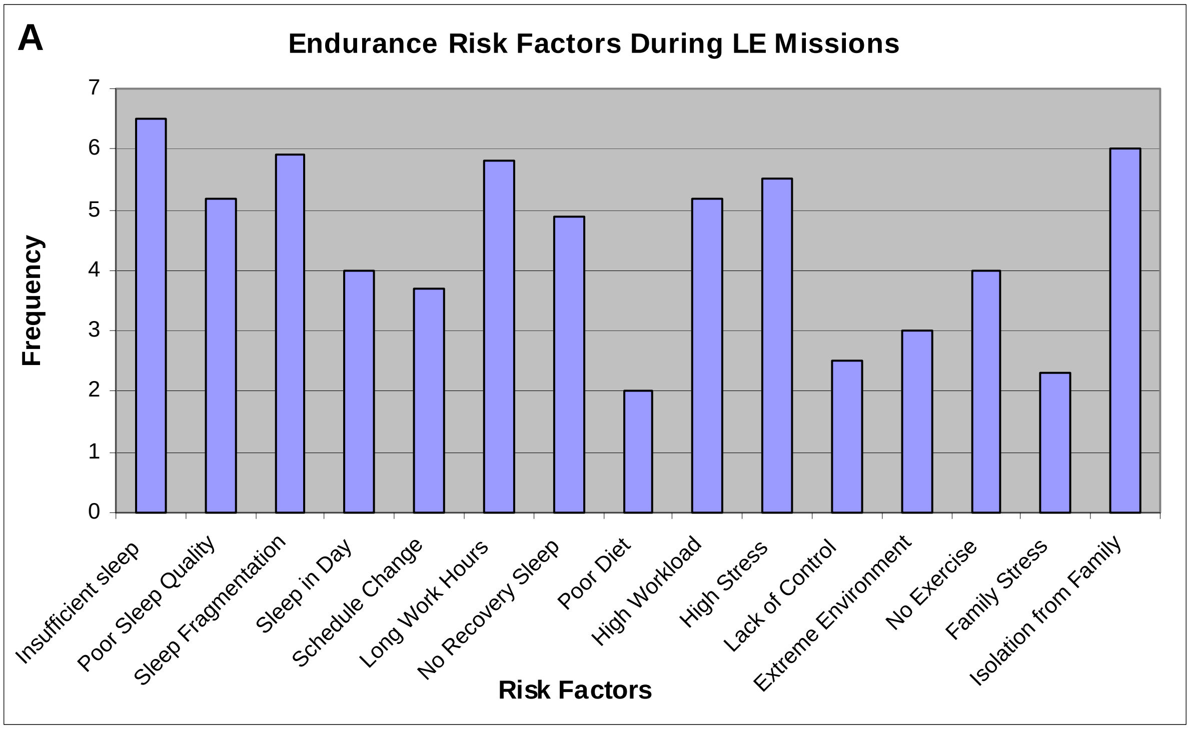
- To which people or departments does each risk factor apply?
- Under what conditions does each risk factor occur?
- How frequently does each risk factor occur?

CREW ENDURANCE RISK ASSESSMENT FORM

Check off any risk factors that pertain to your unit and *write in* the number of days per week (1-7) that each occurs. Also note: (1) to which people or departments they apply; and (2) under what conditions they occur.

1-7

- ❑ __ Insufficient daily sleep duration (less than 7-8 hours of *uninterrupted* sleep; **Sec. 3.3**)
- ❑ __ Poor sleep quality (awakenings during the night due to work-related disruptions, ship motion, or noisy environment; **Sec. 3.3**)
- ❑ __ Sleep fragmentation (breaking sleep into multiple rest periods–"naps"–because unable to take a single, 7-8 hour sleep; **Sec. 3.3**)
- ❑ __ Scheduling main sleep period during the day (the human body is designed to sleep at night; **Sec. 3.3**)
- ❑ __ Changing work/rest schedules (rotating between working days and working nights one or more times per week; **Sec. 3.4**)
- ❑ __ Long work hours (exceeding 12 hours per day; **Sec. 3.3**)
- ❑ __ No opportunities to make up lost sleep (napping during the day is not possible; **Sec. 3.3**)
- ❑ __ Poor diet (menu includes frequent fried foods, high fat and sugar content, frequent caffeine consumption; **Secs. 3.2, 3.5, 3.6**)
- ❑ __ High workload (high physical and-or mental effort requirements; **Sec. 3.6**)
- ❑ __ High stress (caused by extreme environment, high sustained physical or mental workload, rotating work schedules, and-or authoritarian leadership style; **Sec. 3.6**)
- ❑ __ Lack of control over work environment or decisions (workers are isolated and not allowed to contribute in problem identification and resolution; **Sec. 3.6**)
- ❑ __ Excessive exposure to extreme environmental conditions (cold, heat, high seas; **Secs. 3.7-3.9**)
- ❑ __ No opportunity for exercise (not enough time or no equipment/facilities; **Sec. 3.6**)
- ❑ __ Family stress (child and parent care, divorce, finances; **Sec. 3.6**)
- ❑ __ Isolation from family (need to know how family is doing; **Sec. 3.6**)



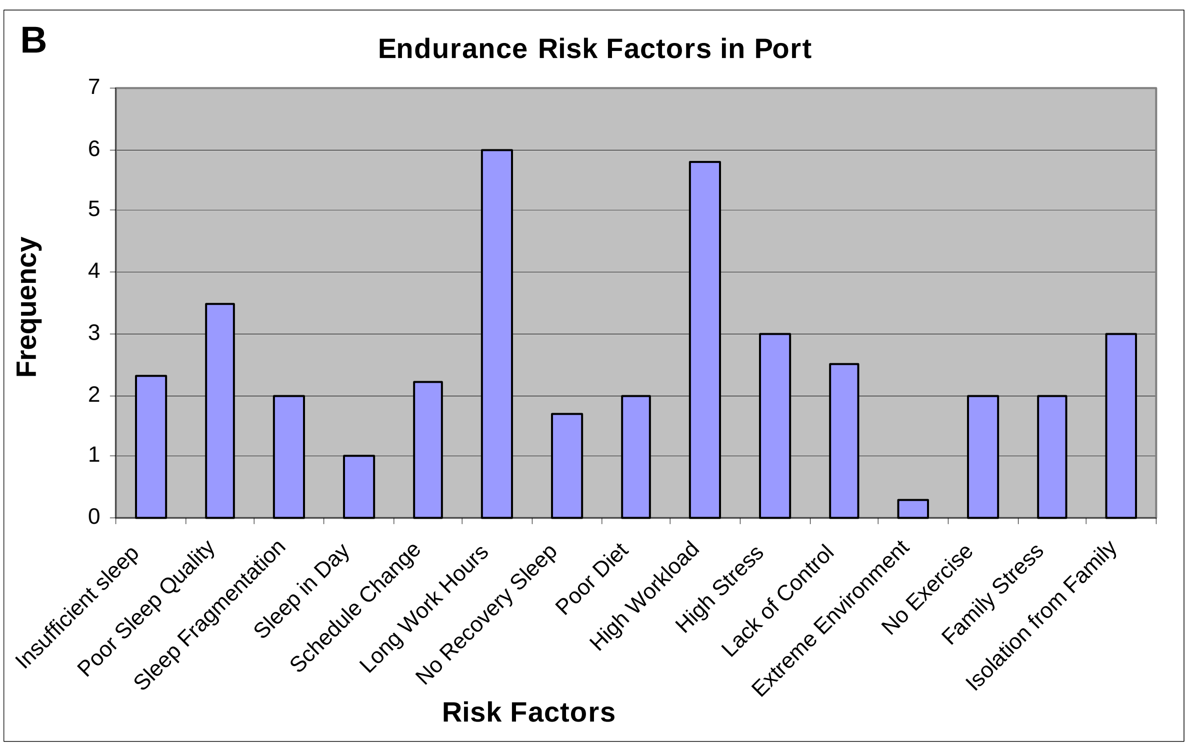


Figure 2-1. Crew endurance risk factors may change depending on the unit's missions and other activities.

For example, if the Working Group checks off the first factor, "Insufficient daily sleep duration (less than 7-8 hours of uninterrupted sleep)," they should discuss under what conditions and how frequently insufficient sleep occurs. Is it an everyday occurrence because normal work schedules do not allow for nine or more consecutive hours off (to accommodate sleeping, showering, and eating)? Or perhaps each crew member only experiences this once or twice a week when they rotate watch schedules or have a special assignment. Or maybe it happens very rarely due to an unusually long SAR case or other mission requirement. Understanding the sources of these risk factors and how frequently they occur allows the unit to determine which factors are the more important contributors to crew endurance risk and which are sufficiently under the unit's control to do something about them.

Notice that ***any*** of the endurance risk factors can significantly degrade performance and compromise operational safety and effectiveness. The detection of ***several*** risk factors affecting unit operations is of great concern because two or more endurance risk factors will interact and impact performance more adversely than would be predicted by the impact of the factors singly (that is, the negative influence of the whole is greater than the sum of its parts).

In addition to the Working Group assessment, it is recommended that Working Group members discuss the endurance risk factors with department or work unit members they represent to ensure that all crew endurance risk concerns are identified. Besides improving the accuracy of the endurance risk assessment, you build ownership in the crew endurance management process for the entire unit.

At this point, you should have a good appreciation for the unit's exposure to crew endurance risk – what are the risk factors and how often are they present. In addition, by reading the appropriate Section 3 material referenced for each risk factor, you can begin to understand why the risk occurs and ways to manage the risk. You are ready to develop a plan to control crew endurance risk (Sec. 2.3.4).

2.3.3 Measuring Crew Endurance Under Your Current Operations

Quantifying the effects of crew endurance risk on the unit is an important element of CEM. The R&DC is developing and testing some easy-to-use tools that will facilitate the collection and analysis of crew endurance data. These tools will be incorporated into the next version of the *Guide*.

2.3.4 Developing a Plan to Control Endurance Risk Factors

In this step, you will create a crew endurance plan for the unit. A brief description is given here; you will want to refer to Section 4 for details and examples. The first step is to review the output from your risk assessment (2.3.2) and read the parts of Section 3 that refer to your prioritized list of crew endurance risk factors. The material in Section 3 discusses each type of crew endurance hazard and provides guidance on selecting and implementing controls. The Working Group takes the information on possible controls from the *Guide*, as well as any controls identified by the Group, and asks the following questions:

- Which can you implement without negatively impacting your mission objectives?
- Which are relatively simple to implement (e.g., improvements to sleeping quarters)?
- Which may be harder to implement, but would be expected to have a wide-ranging and positive impact on crew endurance (e.g., a schedule change)?

Try to plan controls that will eliminate or mitigate as many of your high-priority hazards as possible. To best organize this information for review and presentation, make a table of all the risk factors, the possible controls you have identified to manage the risk, and whether the control(s) can be implemented short-term (6-12 months) or long-term (> 12 months). Also, if appropriate, list any constraints (e.g., lack of qualified personnel) that may limit the use of the control(s). With this table you are ready to proceed with implementing the crew endurance plan.

2.4 Phase II – Implementation

Once you have identified your endurance risk factors, determined their causes and priorities, and developed a plan and controls, you are ready to implement your plan. Implementation is discussed in detail in Section 4.4; it will be briefly reviewed here.

The successful implementation of a crew endurance plan requires buy-in and education at all levels. All personnel must understand the basics of endurance (as presented in Section 3). Sleep and body clock management, as well as stress management, are some of the critical blocks of instruction necessary to make certain all personnel share the same information. Unit command staff and department heads must understand their roles in actively promoting and enabling the crew endurance plan (see Sec. 4.4). All personnel must be aware of the rationale behind the crew endurance plan and the benefits it seeks to provide. Further, all personnel must understand their responsibilities to adhere to the new procedures and policies being implemented in order to give the plan a fair test and to reap the benefits. Coordination of a crew endurance plan requires all levels of an organization to share the responsibility for success.

Once the education program has been carried out, the crew endurance plan is implemented for at least two consecutive months. During this time, department heads and other members of the Working Group need to be attentive to any problems that crop up. Additional education or reminders may be needed to coax personnel into complying with the new procedures and policies. Careful monitoring is necessary during implementation to ensure that aspects of the plan haven't caused any unforeseen, negative consequences. It is not uncommon to make both major and minor adjustments to the endurance plan in order to "work out the bugs." Once changes have been made and the plan appears to be running smoothly, allow the unit to continue with the plan for at least one month before going on to the evaluation step.

2.5 Phase III – Follow-up Evaluation

2.5.1 Evaluating the Crew Endurance Plan

After the crew endurance plan has been running smoothly for about a month, it is useful to evaluate it. Specific suggestions for evaluating your unit's plan are given in Section 4.5.1, including the use of the Crew Endurance Risk Assessment Form (Sec. 2.3.2) as an evaluation tool. By surveying your personnel, you can identify how the plan has affected crew endurance in different departments. This will pinpoint the improvements that have been made as well as areas where improvement is still needed. (A more formal evaluation process is currently being developed and tested by the R&DC and will be included in the next version of this *Guide*.)

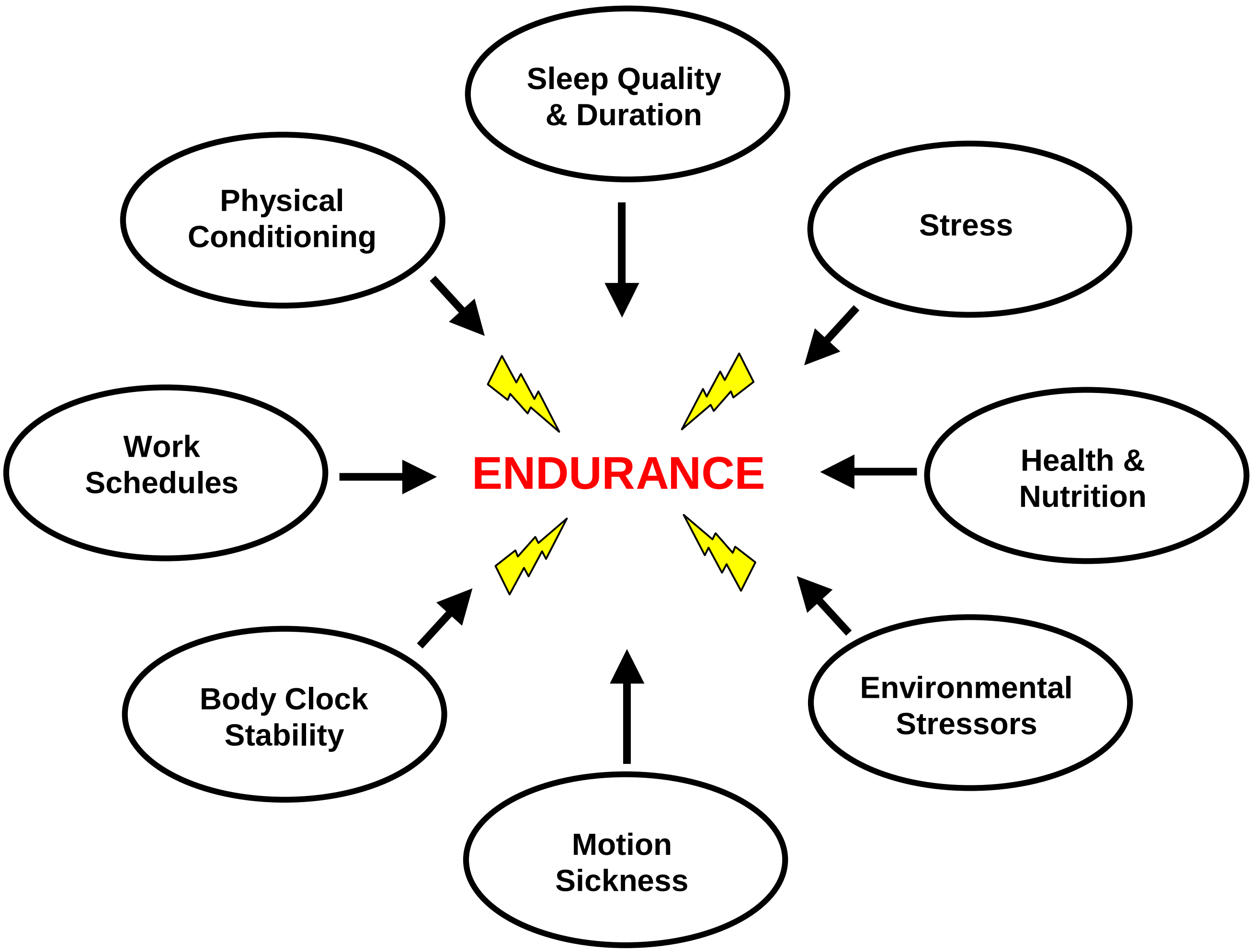
2.5.2 Periodic Reassessment and Continuing Education

As a matter of good crew endurance management practice, it is recommended that the unit maintain an active education program for crew members/personnel and ensure that crew endurance evaluations occur periodically. As discussed more fully in Section 4.5.2, unit missions change and personnel rotate. Both require periodic review and reassessment of the unit crew endurance plan, education for new personnel, and refresher training for others. Devoting time to the review and training of the crew endurance plan serves to remind department heads and personnel that crew endurance is important to the success of Coast Guard missions and that consistent implementation is everyone's responsibility.

3 CREW ENDURANCE HAZARDS AND CONTROLS

3.1 Overview of Section 3

In this section we will explore the concepts which underlie crew endurance. We will learn that “endurance” really refers to “energy;” if we lack endurance, we do not have the energy resources to think clearly and perform our jobs. We will see that there are many factors which reduce endurance (lower energy), and we will discuss some of the more relevant ones to Coast Guard jobs, such as lack of sleep, rotating watch schedules, stress on the job, heat and cold stress, and motion sickness. For each of these factors, recommendations are given for controlling risks and improving endurance.



The topics discussed in Section 3 include:

- the concept of endurance;
- sleep needs, sleep management, and napping;
- work schedules and how to design them;
- caffeine;
- stress;
- cold stress and prevention;
- heat stress and prevention;
- motion sickness.

3.2 ENDURANCE: IT'S ALL ABOUT *ENERGY*

3.2.1 Overview of Endurance

In this section you will learn:

- that endurance depends on energy production;
- the consequences of insufficient energy;
- why it's best to avoid regular use of caffeine and other stimulants;
- personal guidelines for maintaining energy and endurance.

3.2.2 What Is Energy, and How Do We Produce It?

The word "energy" means the capacity to do work. Simply put, if we have energy, we can work; if we do not have energy, we cannot work. Energy is needed by every cell in the human body in order to function properly. In our bodies, energy is packaged as a molecule called adenosine tri-phosphate, or ATP. ATP is found in every cell of the body.

In order to make ATP (energy) we need good nutrition, water, oxygen, and sufficient sleep. Producing energy is one of the main functions of sleep. Studies of the brain have shown that ***seven to eight hours of continuous sleep*** are necessary to restore the energy supplies needed for the brain and body to function well.

Insufficient Sleep = Insufficient Energy

Unfortunately, ATP cannot be consumed as a dietary supplement. It ***must*** be produced within the cells of the body. Do not be fooled by advertisements for nutritional supplements which claim to boost energy resources. They provide dietary input to the body's energy-producing machinery, but they do ***not*** produce energy. The ***only*** way to produce energy is through sufficient sleep and a balanced diet.

3.2.3 What Happens When Our Energy Demands Exceed Production?

The way the human body creates and uses energy is similar to the way an electric company makes and distributes energy. Just as the electric company's energy production capacity limits the amount of electricity that a town can use each day, the amount of ATP our bodies produce limits the amount of energy we can spend. If the human body does not produce sufficient ATP, the brain, the nervous system, and all our other body systems cannot function efficiently. Research clearly shows that when humans experience energy deficits, our physical and mental abilities are significantly reduced. Under these conditions:

- we do not think clearly;
- we become irritable;
- we do not communicate well with each other;
- we become withdrawn and less willing to resolve issues and problems;
- our ability to fight disease is impaired;
- we experience fatigue throughout our work and leisure hours;
- and since we cannot compensate for our lack of energy, our ability to carry out physical and mental tasks is compromised.
- **Thus, we compromise our safety and the safety of those around us.**

3.2.4 Low Energy? Don't Fall into the Stimulant Trap!

Chronic stress and insufficient sleep can be extremely damaging not only to crew members' health, but also to operational safety. Both chronic stress and insufficient sleep deplete energy resources and induce fatigue. Thus, crew members who are not getting enough sleep or who are under significant stress will feel tired, and may seek artificial ways to increase alertness in order to endure job demands. One very damaging threat in this situation is the chronic use of stimulant substances such as caffeine (found in sodas, coffee, and chocolate) and certain medications (e.g., pseudoephedrine).

Caffeine is a stimulant drug. High doses of caffeine can result in:

- increased anxiety,
- lack of concentration, and
- digestive disorders.

Some people have a greater sensitivity to caffeine and experience these symptoms even at low doses. Unfortunately, regular consumption of caffeine will result in addiction and in the ***draining*** of energy resources–the exact opposite effect the user hoped to achieve! For caffeine to serve as an alertness boost, it must be consumed at low levels and only when needed.

Other drugs used in the treatment of allergy and cold symptoms (particularly decongestants containing pseudoephedrine) can boost alertness, but at a high cost if chronic use develops. These drugs are also addictive and marred with severe side effects.

WARNING! All medications containing pseudoephedrine warn against chronic use. In fact, most recommend discontinuation after three days of continuous use and always recommend physician supervision.

3.2.5 Keeping Energy Levels High

We all know that we need sufficient sleep, nutritious foods, and regular exercise to keep our bodies fit–and now we understand how these same elements are necessary to help our bodies make the energy we need. Sometimes the hectic pace of Coast Guard jobs tempts us to shrug off exercise or to pick up fries instead of making a salad. One of the effects of stress and fatigue is to make us want to take the easy way out. So whenever you feel that way, just remember that it's one of your body's signals that you ***need*** to pamper yourself with exercise, nutritious food, and sufficient sleep in order to regenerate the energy you are lacking.

In a nutshell, here is what each and every one of us needs to do daily to keep our energy levels high:

Personal Guidelines for Maintaining Energy

Encourage crew members to:

- ❑ Exercise daily (e.g., any simple form of regular exercise helps: a 20 minute walk, running, weight lifting, 10-minute aerobic workouts, etc.)
- ❑ Consume a balanced diet (e.g., low sugar, low fat, low starch, high in green and yellow vegetables, high in chicken, turkey, and fish).
- ❑ Obtain sufficient sleep (7 to 8 hours of continuous, uninterrupted sleep daily).
- ❑ Manage stress (using relaxation methods to reduce stress at the individual level).

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SLEEP

3.3 Sleep

3.3.1 Overview of Sleep

In this section you will learn:

- that people need 7-8 hours of sleep to perform their best;
- that sleep is when the body produces energy;
- about the “body clock” and how it regulates energy and alertness;
- the importance of keeping regular sleep and light-exposure schedules;
- guidelines for personal sleep management;
- how napping can help maintain endurance on the night watch;
- how napping can help maintain endurance under continuous operations.

3.3.2 Sleep Requirements

The human brain requires approximately ***seven to eight hours*** of uninterrupted sleep daily, to replenish energy resources. During sleep, the brain cycles between periods of light, deep, and dream sleep (see Appendix A for specific details). One complete cycle (that is, going from light sleep to deep sleep to dream sleep) takes approximately 90 minutes. The 90-minute cycle is repeated throughout the sleep period. Sleep can be disrupted by noise, bright lights, or movement. Such interruptions cause the brain to spend more time in light sleep. This means the brain spends less time in deep sleep, when most of the energy restoration occurs. Thus, sleep disruption reduces the efficiency of the energy restorative processes and results, inevitably, in degraded cognitive and physical functioning upon awakening.

> **FACT:** Energy is optimally produced during uninterrupted sleep periods of seven to eight hours in duration on comfortable mattresses, in dark and quiet rooms, and at environmental temperatures between 60-75 °F.

Interrupted sleep and reductions in sleep duration below seven to eight hours per day will result in the accumulation of daily sleep debt. The consequences of this debt will be experienced first in the degradation of alertness, decision-making ability, and logical reasoning. Persistent sleep debt throughout a week will result in increased daytime sleepiness and degradation of performance in cognitive and psychomotor (e.g., hand-eye coordination, reaction times) tasks.

3.3.3 The Biological Clock and Energy Availability

Optimally, sleep must take place during a period of time regulated by the human biological clock (or body clock). This internal "clock" regulates the timing of sleep onset and wake-up time. Our bodies are naturally predisposed to sleep during the night and to be awake and spend energy during daylight hours.

Figure 3-1 shows how our energy level changes over the course of a day. The biological clock regulates energy cycles so that alertness:

- increases after wake-up time,
- peaks in the mid-morning hours,
- dips in the afternoon hours ("post-lunch dip"),
- peaks again in the early evening hours,
- begins to decrease at night, and
- reaches its greatest lows in the middle of the night and the early morning hours (approximately midnight to 0600).

The exact times of these peaks and valleys depend on specific inputs to the biological clock, namely wake-up times, bedtimes, and daily times of exposure to daylight (and-or artificial bright light). As we will see later, the timing of daily exposure to bright light sets the body clock and is, thus, a key determinant of body clock stability (or instability).

FACT: Personnel who keep regular schedules, having consistent work, sleep, and light-exposure times from day-to-day, enjoy the benefits of a well-adapted biological clock. This allows daily energy-restorative cycles to take place on a regular basis and makes energy available during normal work periods.

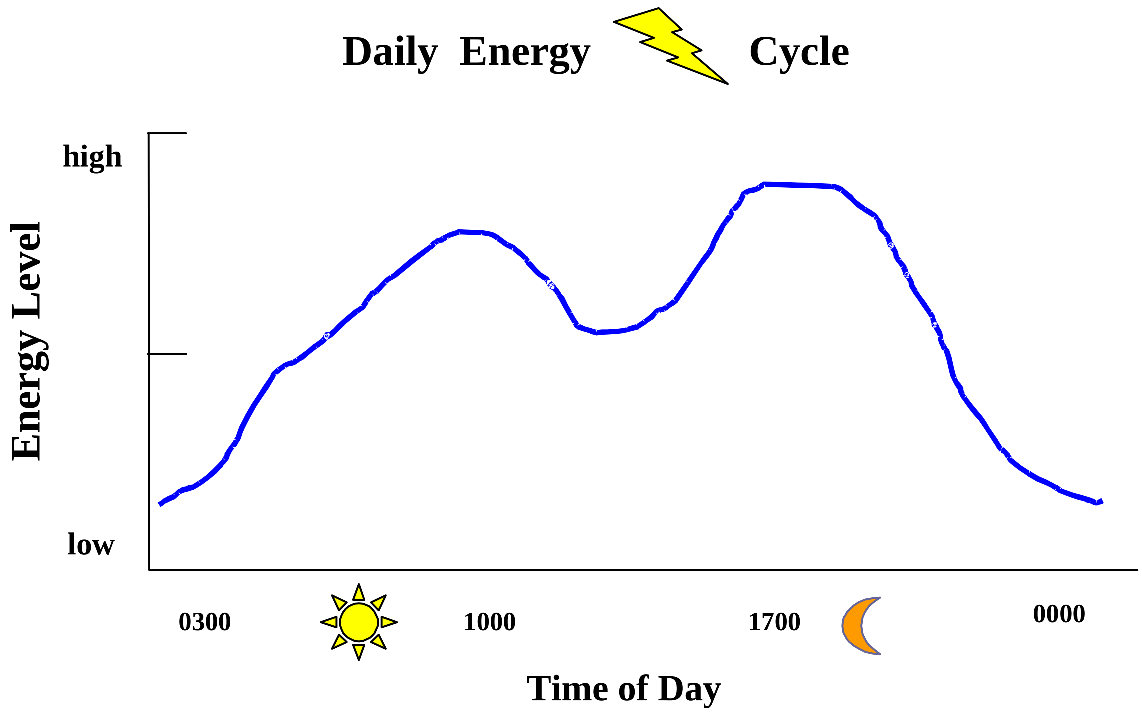

Figure 3-1. Daily energy cycle as a function of time of day.
Energy cycles and alertness fluctuate with time of day. Specific times of peaks and valleys in alertness depend on bedtimes, wake-up times, and times of exposure to bright light.

3.3.4 Promoting Endurance Through Good Sleep Management

Many times the ability to achieve good quality sleep depends on good sleep habits. It is unwise to become dependent on sleep medications for a variety of reasons, and when one adheres to some common sense behavioral strategies for sleep, sleep aids may not be necessary except in extreme situations. Leaders and personnel should be aware of the factors that can affect the ability to sleep and the quality of sleep achieved (see box, next page).

Occasionally people have problems falling asleep. If you cannot fall asleep after about 30 minutes in bed, do not remain in bed awake: get up to avoid associations of waking and anxiety with bed. Stay out of bed until you feel tired: eventually, fatigue will take over. Additionally, a person who has trouble falling asleep during the normal sleep period should not nap during the day, as napping may delay sleep onset.

Sleep Management

Planning for sleep

- The amount of sleep each person needs varies: while the average person needs 7-8 hours of sleep per day, some people need only 5-6 hours, while others may need 9-10 hours. If, after sleeping your normal amount at night, you feel very sleepy during the afternoon hours, you need more sleep.
- Try to sleep (go to bed and get up) at the same time every day, including on days off.
- Avoid foods and drinks that contain caffeine (e.g., coffee, tea, soda, chocolate) four to five hours before bedtime.
- Avoid exercise one hour before bedtime since it has a temporary alerting effect.
- If a sleep aid was taken previously, the first and possibly the second night of sleep without medication may be disrupted. Falling asleep may be delayed, and the person may awaken several times during the night. However, this will subside within one or two nights.
- Alcohol should never be used to promote sleep. Although alcohol may induce sleep onset, the quality of sleep will be disrupted and less restful.

Good sleep habits

- When trying to sleep outside the usual sleep period (e.g., during the daytime), prepare as if it is the normal sleep period – wear normal sleep clothes, darken the room as much as possible, keep noise to a minimum, and use a white-noise generator, such as a fan, to mask out surrounding noise.
- Use bed only as a place to sleep: do not read, work, or do other similar activities in bed. Associating bed with sleep will eventually allow sleep to come more easily.
- If you must stay awake for 24 to 48 hours, do not sleep overly long (more than ten hours) afterwards. Sleeping too long may interfere with the normal sleep/wake schedule and will cause significant lethargy during the day. The normal sleep period for an individual is usually sufficient to recover from 24 hours without sleep.

3.3.5 Napping: An Important Tool for Endurance Management

Naps can be an effective, temporary “shot in the arm” for endurance when used appropriately. There are two primary uses of naps:

(1) to help personnel adjust to a change in work schedule from daytime to nighttime work; and
(2) to help restore energy when personnel are exposed to high tempo operations for very long work periods (greater than 12 consecutive hours/day and-or continuous operations).

Napping is never a substitute for sleep; however, it can be very helpful in “reviving” personnel who do not have time for a full sleep period.

Naps should be taken during the afternoon low point in our energy cycles, because the body is more ready to sleep at that time (refer to Fig. 3-1). Research has shown that a two-hour nap taken in mid-afternoon (around 1500 hours during the “post-lunch dip”) results in greater restoration of alertness than a two-hour nap taken in the evening (e.g., around 1900 hours when the energy cycle is on the rise). However, naps taken after midnight should be avoided. While it will be easier to fall asleep after midnight, it is also much harder to wake up after a late-night nap: one may feel groggy and suffer performance degradations for more than an hour after waking up.

3.3.5.1 Napping and Change of Work Schedule

When personnel must shift work schedules from daytime work to nighttime work, naps can facilitate body clock adjustment. Naps are recommended if:

- you rotate from day to night duty, *and*
- you cannot sleep more than four or five hours during the sleep period following your first night work, *and*
- the next night is going to be another work period.

Napping to Adjust to Night Work

- When shifting from daytime to nighttime duty hours, opportunities for naps may occur during the following time periods:

  - During the mid-afternoon (e.g., around 1500 hours);
  - During the evening prior to reporting for work (e.g., nap from 1600 to 1900 hours when reporting for duty at 2100 hours).

- When rotating to the night watch, personnel should be encouraged to use naps during time-off to compensate for sleep loss incurred during the transition to nighttime duty hours.
- When transitioning from daytime to nighttime duty hours later the same day, a nap at 1500 hours may well compensate for sleep loss incurred during the assigned sleep period.
- Daytime naps longer than one hour are not recommended if your next sleep period will take place that same night. In this case, naps taken during the day may interfere with the onset and duration of that night's sleep.

3.3.5.2 Napping and Continuous Operations

If personnel are subjected to continuous operations or very long work days (greater than twelve hours), napping can help to temporarily restore dwindling energy levels. If the pace of operations or the available staffing level permits, naps can be used to sustain performance during the long/continuous work period. Command and department heads should encourage preventive napping. Allow time and provide a quiet, comfortable place for short naps as the mission permits. Educate personnel about the benefits of napping, and inform them that naps are not a substitute for sleep. Napping during continuous operations will reduce performance impairment but will not totally alleviate the effects of sleep deprivation. Individual differences in sleep needs must be considered in determining nap length. Several factors are important to consider when scheduling naps, including whether there is already sleep loss, the length of the nap, and when to take the nap.

Napping and Continuous Operations

Pre-existing amount of sleep loss

- The best time to nap is ***before*** significant sleep loss has occurred. These naps will help prevent subsequent performance impairment during continuous work schedules. Personnel who nap for one to four hours prior to a night work period will show improved subsequent late-night and early-morning performance and alertness compared to those who do not nap. Preventive napping may be better than a nap during the sleep-deprivation period.
- Naps do not totally eliminate the energy cycle dip experienced in the early morning (between 0000 and 0600), but the degradation in both cognitive performance and alertness is reduced.

Nap Length

- Naps should be as long as possible.
- A single two-hour nap during a 24-hour continuous work period can refresh the individual and cause performance to be close to pre-sleep-loss levels.
- If longer naps are not possible, several naps of as little as ten minutes each can help personnel endure continuous operations.

Timing of Naps

- It is easier to nap when the energy cycle is at its lowest (around 0300 and 1500 hours) and more difficult when the energy cycle peaks (around 1000 and 1900 hours).
- Early morning naps (0000 to 0600 hours, during the energy cycle "low period") are beneficial in restoring alertness and performance. However, post-nap sleepiness will be higher and performance will be lower for an hour or more after awakening from a nap at this time. Therefore, personnel should be awakened from early-morning naps at least an hour before reporting for duty in order to allow them to fully recover from the nap.
- It is better to time naps so that the person is awakened during an energy rise/peak (e.g., between 1000 and 1400 hours or between 1700 and 2000 hours), because there will be less post-nap sleepiness and better performance. Even so, one should allow about 20 minutes to recover after a nap.

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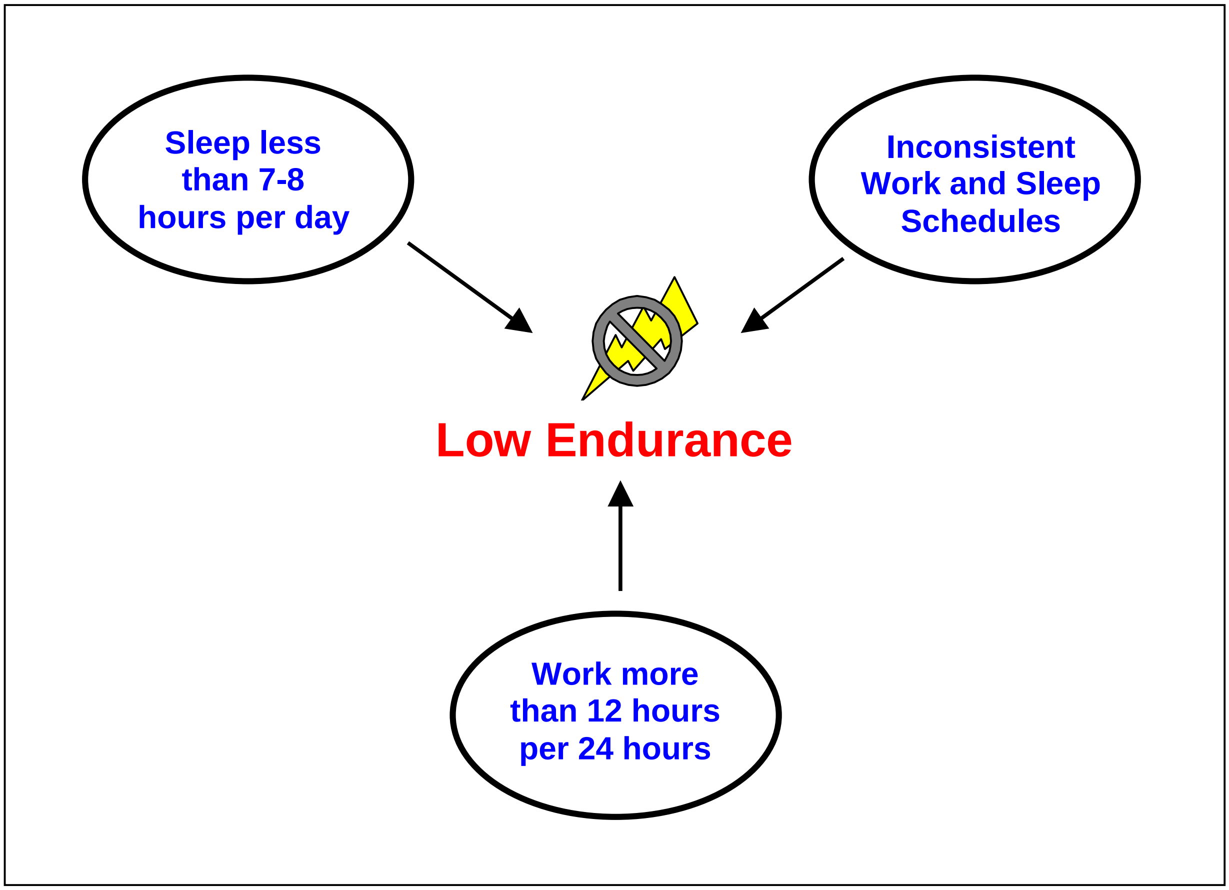
WATCH SCHEDULES



3.4 Watch Schedules

3.4.1 Overview to Watch Schedules

In this section you will:

- learn how watch schedules directly support or degrade endurance;
- understand why working at night can result in “jet-lag” symptoms;
- see the immediate and long-term performance and health degradations which accompany body clock disruptions caused by poor watch schedules;
- evaluate typical CG watch rotations and consider healthier alternatives;
- learn how to help your personnel adapt to night duty.

3.4.2 How Watch Schedules Can Lead to Poor Endurance

As discussed previously, we can keep our body clock stable by keeping to a routine in which

- bedtimes,
- wake-up times, and
- times of exposure to bright light

stay about the same from day to day. When the body clock is stable, endurance is high: we will have the energy we need for work and leisure activities, and our bodies will be primed for efficient, restorative energy production during our sleep periods. In contrast, watch schedules that impose frequent transitions from daytime to nighttime duty hours, or even changes in wake-up times of as little as two hours, disrupt energy restorative processes and degrade alertness and performance (poor endurance).

For instance, maintaining a summer watch schedule that requires waking up about 0700 on most days of the week, but requires an earlier wake-up time (e.g., 0500) on some workdays, will send conflicting signals to the biological clock. On the days that earlier wake-up times are required, the earlier exposure to daylight (or bright artificial light) will signal the body clock to advance bedtimes and wake-up times (i.e., to make them earlier). Conversely, on the days when wake-up time (and exposure to bright light) has been delayed to 0700, the body clock is signaled to delay bedtimes and wake-up times.

These changes in the body clock’s timing are important because they have wide-ranging effects on our physiology. Body clock changes affect the normal regulation of physiological functions such as:

- core body temperature,
- cellular metabolism,
- the production and release of hormones and neurotransmitters,
- the timing of sleep (energy production), and
- the timing of alertness (energy availability).

WARNING! Inconsistent inputs to the biological clock are common when personnel work during nighttime or early morning hours. When dim or normal lighting (as opposed to bright light) is provided during the night watch, and personnel are exposed to daylight after sunrise, it will result in inevitable degradation of sleep during the day and of performance during the nighttime duty period.

In general, the biological clock requires approximately ***three days*** to readjust to a new input, such as a two-hour advance in exposure to daylight due to earlier wake-up times. This readjustment will take place if the new sleep/wake schedule is consistent from day to day. However, if the inputs are inconsistent (that is, the times of wake-up and exposure to light change every few days—as is true in many CG watch rotations), the body clock's timing can become disorganized (disrupted) in such a way that physiological functions under its control will no longer occur in a predictable pattern.

FACT: Inconsistent inputs to the body clock can result in:

- Sleepiness on watch
- Paradoxical feelings of fatigue, "feeling too tired to sleep"
- Lack of mental clarity
- Degraded physical ability

3.4.3 The Problem With the Night Watch

Inconsistent inputs to the biological clock are common when personnel work nighttime shifts. For instance, a watch schedule prescribing a six-hour watch during the night (e.g., from midnight to 0600) can result in jet-lag-like symptoms. If night-duty personnel work under normal lighting (e.g., in engineering or in a communications center) or in dim light environments (e.g., on the bridge), exposure to daylight (sunrise) at the end of the watch will set the biological clock to a daytime orientation. This will adjust the body's energy cycle to make energy available during the day and to prepare the body for sleep at night–precisely the opposite of what is desired for someone on the night watch!

FACT: In a daytime orientation, the biological clock predisposes the brain and energy cycles for sleep, and not work, during nighttime. Inevitably, fatigue-induced performance degradation will occur during nighttime hours.

Studies of the performance of night-shift workers show a consistent reduction in work efficiency, and in some cases, safety. Here are some examples:

- Truck drivers have been shown to have twice as many accidents between 0000 and 0200 compared to during the day.
- Locomotive operators have an increased probability of missing warning signals when working the night shift.
- Night-shift workers perform worse on tasks of vigilance and reaction times compared to day workers.
- Aviators flying a flight simulator at night have reduced hand-eye coordination, poorer vigilance and calculation proficiency, and impaired flight performance compared to day fliers.

3.4.4 Insufficient Sleep and Body Clock Disruption: A Double Whammy

Poor watch schedules, particularly those which cause personnel to change their bedtimes and wake-up times two or more times per week, cause body clock disruption. As discussed above, when the body is unable to adapt to changing work schedules, it often results in difficulty falling asleep and getting good-quality, consolidated sleep (people usually experience lighter sleep with many awakenings). Therefore, body clock disruption and insufficient sleep often go hand-in-hand. Poor adaptation to work schedules and a lack of sufficient, energy-restorative sleep (7-8 consolidated hours per day) can result in persistent fatigue symptoms:

- sleepiness,
- low energy,
- lack of motivation,
- irritability,
- depression,
- and, in extreme cases, psychosis.

There are performance effects as well:

- performance degradation during duty hours, and
- reduced safety.

Other health effects, which have been documented in workers on schedules that prevented body clock adaptation (U.S. Congress, 1991), include:

- increased incidence of cardiovascular disease (heart attack),
- gastrointestinal (digestive) disorders, and
- sleep disorders.

3.4.5 Promoting Endurance Through Good Watch Schedules

> **MANAGEMENT NUGGET:** To maintain energy restoration and prevent fatigue, use watch schedules that do not frequently disrupt regular sleep schedules.

In order to maintain good crew endurance, it is imperative to keep personnel on as consistent a sleep schedule as possible. Rotating watches are very common in the Coast Guard, and as just discussed, such schedules disrupt the body clock and cause fatigue. By seeking ways to keep personnel on a more regular, consistent sleep/wake schedule, we help stabilize the body clock, which in turn enables our personnel to be more alert and perform better on watch and allows them to get better-quality, more-restorative sleep.

Sometimes we do things because “that’s the way it’s always been done.” What may have made good sense years ago may no longer be needed for today’s missions or with today’s technology. Our watch schedules are often based more on tradition than on actual need. For example, on cutters, most people stand a four-hour watch. Why four hours? Perhaps a longer or shorter watch would work better (especially for a 1-in-4 or 1-in-5 schedule) and allow personnel to keep stable hours. In some cases, a watch may not be needed 24 hours per day. Or, the number of personnel on watch might be reduced, allowing other personnel to be day workers. In a similar vein, cross-training personnel and reassessing whether “all-hands” evolutions really require all hands are other ways to make needed personnel available and still enable night watchstanders to get that ever-important uninterrupted sleep. As you think about your current watch schedules, and as you design new ones, consider the following points:

- *Is this watch necessary?* -- Is it really necessary to have personnel standing this watch 24 hours/day, everyday? Are there certain days, certain times of day, or certain types of operations when this watch is not needed?
- *Does everyone need to stand watch?* -- How many watchstanders are really needed? Could other people be assigned to day work, rather than stand a watch?
- *Can the watch be consolidated with other duties?* -- That is, can watchstanders simultaneously complete other tasks so that they do not have

additional work to do after the watch? Not having to get up for day work would allow a night watchstander to obtain needed sleep.

- *Does the watch need to be 4 hours long?* -- If not, it gives you much more freedom in designing a better watch schedule.
- *Think about the **body clock**, rather than just the number of crew, when establishing the watch schedule.* -- Too often we count the number of people we have to stand watch and select one of the traditional rotations, such as 1-in-4 or 1-in-5, thinking that we have helped our personnel because they are standing fewer watches. In reality these schedules ***hurt*** our personnel because it puts them on a rotating schedule to which the body clock cannot adjust. Instead, we want to design new schedules that will support body clock stability: schedules that allow personnel to stand watch at the same time day after day.

Now let's take a look at some typical Coast Guard watch schedules and how we can improve them. First we'll look at the standard 1-in-3 and 1-in-6 watch schedules. Both these schedules have the beneficial attribute of being stable: each watchstander works the same schedule every day. This helps to keep the body clock stable. After that we'll look at the 1-in-4 and 1-in-5 schedules. These are particularly bad because personnel are on watch at a different time each day, which causes sleep periods to shift from day to day, leaving the body clock badly disrupted. Suggestions will be given for improving these schedules.

3.4.5.1 Traditional Schedules: 1-in-3 and 1-in-6

First, consider the standard three-section watch rotation (1-in-3; see Table 3-1). In this watch rotation, there are three duty sections (shown as A, B, and C). On each day, the first duty section (A) is on watch from midnight to 0400 and again from noon to 1600. The second duty section (B) stands watch 0400-0800 and 1600-2000. The third duty section (C) stands watch from 0800 to noon and again from 2000 to midnight. Because personnel are on watch at the same times day after day, this schedule supports body clock stability.

However, with only 8 hours off between watches, it will not be possible for personnel to obtain the recommended 7-8 consecutive hours of sleep (because they need part of the eight hours for meals, showering, etc.). This means personnel should be encouraged to take a nap during their other off-watch period. Those members on the night and early-morning watches (0000-0400 and 0400-0800, respectively) will need to pay attention to the light management and other recommendations for adapting to nighttime duty at the end of this section.

Regarding the 1-in-3 watch schedule, the personnel on the "mid" watch (section A in Table 3-1) will probably be the ones who have the most difficulty maintaining endurance. This is because they often have day work which precludes their ability to get sufficient sleep after coming off the "mid" (midnight) watch. As a result, people

Table 3-1. Standard 3-Section Watch.

Standard 1-in-3 Watch			
	Day 1	Day 2	Day 3
0000-0400	A	A	A
0400-0800	B	B	B
0800-1200	C	C	C
1200-1600	A	A	A
1600-2000	B	B	B
2000-0000	C	C	C

working the mid watch often get a few hours of sleep after the night watch and try to grab a nap in the afternoon (if other work allows it). One possible improvement would be to absolve the mid watch from day work, to allow them to get their sleep. Another alternative, if sufficient personnel are available, would be to split the mid watch between two people, so that one stands the 0000-0400 watch and the other stands the 1200-1600 watch.

Some other potential variations to the 1-in-3 are:

- Make watchstanding the sole scheduled work (to allow more time for sleep). If you can't do this for all watchstanders, at least try to do this for personnel on the mid watch.
- Reduce "day work," especially for personnel on the midnight watch, so they can get sufficient sleep.
- Stand 8 hour watches (leaves a longer period in which to get sleep).

3.4.5.2 The 1-in-6 Watch Schedule

The standard 1-in-6 watch schedule is the best watch schedule because there is no rotation and personnel have lengthy periods in which to get the 7-8 consolidated hours of sleep they need (Table 3-2).

Table 3-2. Standard 6-Section Watch.

Standard 1-in-6 Watch			
	Day 1	Day 2	Day 3
0000-0400	A	A	A
0400-0800	B	B	B
0800-1200	C	C	C
1200-1600	D	D	D
1600-2000	E	E	E
2000-0000	F	F	F

3.4.5.3 Traditional and Alternative Schedules: 1-in-4

When a department has a sufficient number of qualified personnel, they will often go to a 1-in-4 or 1-in-5 schedule. While these schedules may seem at first to offer benefits (reduced number of duty hours per day), the 1-in-4 and 1-in-5 watch rotations are very disruptive to the body clock.

Table 3-3 shows the standard 1-in-4 watch rotation (left half) and an improved, alternative 4-section watch (right half). The standard 1-in-4 has personnel working two watches on one day and one watch at a different time on the next day. Take duty section A as an example. On the first day, these personnel stand the midnight-0400 watch and the 1600-2000 watch. Sleep would probably follow the night watch, at about 0430-1200. One nice thing about this schedule (compared to the 1-in-3) is that there is sufficient off-watch time for a full 7-8 consecutive hours of sleep. As just mentioned, this person gets off the evening watch at 2000, but probably will not be able to sleep at this time since they got up at noon. This person's next watch starts at 0800, so going to bed from 2300-0700 will give sufficient time for sleep--if they can sleep. Notice wake-up time (and light-exposure time) has been advanced by ***five hours***—a significant advance that can take several days to adapt to. Yet, that very night, this person must switch back to (and hopefully be able to maintain alertness during) a midnight-0400 watch. This schedule is like crossing back and forth over five time zones every day! Personnel on this type of schedule will suffer from chronic body clock disorganization and flagging alertness levels.

Table 3-3. Standard and Alternate 4-Section Watch.

Standard 1-in-4 Rotation				**Alternate 4-Section Watch**			
	Day 1	Day 2	Day 3		Day 1	Day 2	Day 3
0000-0400	A	C	A	0000-0300	A	A	A
0400-0800	B	D	B	0300-0600	B	B	B
0800-1200	C	A	C	0600-0900	C	C	C
1200-1600	D	B	D	0900-1200	D	D	D
1600-2000	A	C	A	1200-1500	A	A	A
2000-0000	B	D	B	1500-1800	B	B	B
				1800-2100	C	C	C
				2100-0000	D	D	D

A much-improved alternative is the 4-section watch schedule shown on the right half of Table 3-3. In this schedule, there are four watch sections, each working two, ***three-hour*** watches per day. This schedule provides nine consecutive hours of off-duty time—sufficient time to obtain 7-8 consecutive hours of sleep. The hallmark of this schedule is that each watch section stands watches ***at the same times every day.*** Thus, personnel can become adapted to a regular schedule, allowing them to be more alert on duty and to get more restorative sleep during sleep periods.

Some other potential variations to the 1-in-4 are:

- Stand the "1-in-3" watch and split the "mid-watch" between 2 people (one person works mid-0400 and the other works noon-1600).
- Stand the "1-in-3" and have one "floater" that rotates into the watch (e.g., for first month, persons A, B, and C stand watch and floater (D) does not; second month D replaces A; third month, A replaces B; etc.).
- Stand 3-hour watches (like right side of Table 3-3).
- Stand 6-hour watches.

3.4.5.4 Traditional and Alternate Schedules: 1-in-5

Table 3-4 (left half) shows the typical 1-in-5 watch rotation. On most days personnel have only one, four-hour watch; once every five days they stand two watches. On the surface this would appear to be a very nice watch schedule; it would appear that there would be plenty of time to get sleep. Unfortunately this is not truly the case. This schedule rotates in the counterclockwise (backward) direction: each day's watch occurs four hours ***earlier*** than the day before. Likewise, sleep periods and wake-up times will also keep shifting.

Table 3-4. Standard and Alternate 5-Section Watch.

Standard 1-in-5 Rotation				**Alternate 5-Section Watch**			
	Day 1	Day 2	Day 3		Day 1	Day 2	Day 3
0000-0400	A	B	C	0000-0400	A	A	A
0400-0800	B	C	D	0400-0900	B	B	B
0800-1200	C	D	E	0900-1400	C	C	C
1200-1600	D	E	A	1400-1900	D	D	D
1600-2000	E	A	B	1900-0000	E	E	E
2000-0000	A	B	C				

Take, for example, duty section A in Table 3-4 (left side). On Day 1, they stand two watches: midnight-0400 and 2000-0000. This gives them a chance to sleep after the first watch at about 0430-1200. They would probably attempt to sleep after the second watch (the beginning of Day 2) from 0030-0800 or so. Already we see an advance in bedtimes and wake-up times of 4 hours from Day 1 to Day 2. They would stand their 1600-2000 watch on Day 2 and could sleep 2300-0700 (about a one-hour advance in wake-up time). If the duty section understood body clocks, they would attempt to keep this same sleep time for the next two days, since their watch schedule would allow it (Day 3 watch is 1200-1600 and Day 4 watch is 0800-1200 (A's Day 4 is the same as C's Day 1)). But since the Day 6 watch starts at 0400, sleep times will have to advance to about 2000-0330. Hopefully they could grab a nap prior to their Day 7 (same as Day 1) midnight-0400 watch; otherwise, they will be awake for over 24 hours before their next sleep opportunity.

It is easy to see how disruptive this schedule is. One might argue that there's plenty of time for these people to take naps. The problem is that people are not able to nap at any given time. As we saw in Figure 3-1, our energy cycles prevent our getting sleep during much of the day. The best times to attempt a nap are when our energy levels are at their low points. To further complicate matters, when our body clocks are badly disrupted (as is the case with this schedule), our physiological cycles get out of synch, and it becomes hard to predict when we will be able to get sound sleep. We often experience great fatigue, only to find that we can't get to sleep even if we try. That is why it is so important to keep sleep schedules as consistent from day to day as possible: a stable body clock makes energy available when we need it and allows us to sleep soundly when we go to bed.

One alternative to the 1-in-5 rotation is shown on the right half of Table 3-4. This 5-section watch schedule has one duty section (A) which works a four-hour watch at midnight, and four duty sections (B-E) which each stand a five-hour watch. Watch times are consistent from day to day. This schedule provides duty sections C, D, and E the opportunity to get a full eight hours of sleep at night (i.e., to maintain a normal "day" orientation for their body clocks). Section A works midnight to 0400, but should be able to get sound sleep if they go to bed before sunrise (and use dark glasses during times of year the sun rises early). Section B probably has the least desirable schedule of the group, since they would have to go to bed by 2000 if they are to obtain 7-8 consolidated hours of sleep. However, since their schedule is constant from day to day, they will have better endurance than on the traditional 1-in-5, even if they get only 6 consecutive hours of sleep and take a 1-2 hour nap later in the day.

Some other potential variations to the 1-in-5 are:

- Stand the "1-in-3" and have two "floaters" who rotate into the watch.
- Stand the "alternate 1-in-4" (right side of Table 3-3) and have one "floater."

3.4.5.5 To Rotate, or Not To Rotate? And How Often?

Most people do not enjoy working the night watch all the time. If mission requirements or personnel desires do not mesh with keeping the watch sections stable for the entire tour, then allow rotations on a monthly or biweekly basis (try not to change schedules more frequently than every 14 days). Also, always rotate schedules in a ***clockwise*** direction, so that crew members are getting up ***later*** rather than earlier for the new watch. For example, in the 3-section watch shown in Table 3-1, duty section A is on the 0000-0400 watch. If the watch schedule is to be rotated, they should be switched to the 0400-0800 watch (a clockwise delay in time). One might make such rotations at noon: the 0800-1200 watch could be extended to 1400 (i.e., a one-time, 6-hour watch), and the next watch would work 1400-2000. After that, the watch sections would be on their new four-hour watch schedule. Remember, every time the schedule changes, it will take about ***three days*** for the body clock to readjust. The longer crew members stay on the same schedule, the better adapted they will be.

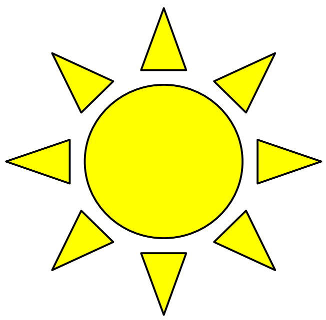
In summary, optimizing crew rest and preventing body clock disruption can contribute significantly to good endurance. Here are some critical recommendations that, if implemented, will help keep personnel alert and adjusted to their work schedules.

Designing Good Watch Schedules

- Avoid the use of frequently rotating watch/work schedules at all costs.
- If you must use rotating schedules, make sure that personnel remain on the same schedule for at least two weeks and that they rotate forward (e.g., from mid-0400 to 0400-0800) rather than backwards (e.g., from 0400-0800 to mid-0400).
- Avoid allowing personnel to work more than 12 hours in a given 24-hour day. Count the 24 hours beginning from crew members' wake-up time from their normal (longest) sleep period (not naps).

3.4.6 Light Management and Adaptation to the Night Watch

One of the causes of poor endurance is a watch schedule that does not allow the body clock to adapt to a consistent, daily routine. Adaptation to nighttime or daytime work requires the synchronization of physiological and cognitive resources under the regulation of the biological clock. In order to adapt the biological clock, personnel must see daylight (or bright artificial light of 1,000 lux or greater) upon awakening and throughout their active periods (i.e., during work hours). ***Light management is critical for proper adaptation to watch/work schedules.***



FACT: Daylight or sufficiently bright artificial light (≥ 1,000 lux) is the necessary input to set the body's clock.

MANAGEMENT NUGGET: The only way to fully adapt to night watch schedules is to reset the biological clock so that energy peaks during nighttime. Work must take place under artificial bright lights (approximately 1,000 lux or greater) mimicking the effects of daylight. Sleep must take place in a dark and noise-free environment for approximately seven to eight hours.

If the use of bright, artificial light is incompatible with the work environment (e.g., on the bridge of a cutter or the cockpit of a helicopter at night), a specific light and sleep management schedule can be designed to shift the biological clock towards a night orientation. Since experimentation with light exposure schedules can result in chronic fatigue symptoms, it is recommended that a professional (such as the Crew Endurance Team at the CG R&D Center) be consulted.

Adaptation to the Night Watch

- Adaptation to the night watch requires bright light exposure (at least 1,000 lux) throughout the watch period. This can be accomplished in most shipboard and shoreside environments (e.g., engineering spaces, communications centers). However, where night vision is required (e.g., on the bridge), those personnel can only achieve *partial* adaptation to the night watch (see next page, "Special Considerations for Partial Adaptation to the Night Watch").

- To promote good adaptation to night work, personnel must see daylight or sufficiently bright artificial light (e.g., at least 1,000 lux) after they awake from their daily (longest) sleep period and as much as possible throughout their waking period. Exposure to daylight provides a critical input that facilitates the body clock's adjustment to the sleep/watch schedule.

- Promote exercise in the evening hours.

- Provide nighttime personnel with small size meals that promote energy and alertness: high protein, low fat, low sugar, low starch, no dairy products, no turkey (dairy and turkey can cause sleepiness). A low-fat diet is particularly important during the first three days after rotating to a night schedule, as gastrointestinal disorders are more likely while the body is trying to adjust to the new schedule.

- Adjust meal times so that nighttime personnel can eat a brunch upon awakening (approximately 1300), including brewed coffee and breakfast foods if desired.

- Always adapt the mess services to serve personnel's needs. Make hot, nutritious meals available at times coordinated with the various watch schedules. Provide access to nutritious snacks or self-serve meals around the clock. This effort supports both safety and crew morale.

<u>Special Considerations for Partial Adaptation to the Night Watch</u>

- There are three approaches to reducing fatigue under partial adaptation conditions. The preferred approach is to allow personnel on the mid-0400 watch (or any other night watch that ends in the morning hours) to retire *prior to sunrise* and then obtain a consolidated seven to eight hours of sleep, free of noise and with <u>absolutely no interruptions</u>. It is critical not to allow interruptions during the long block of sleep. Daytime work or other duties should be scheduled to occur after wake-up time (e.g., from 1400-1800). Leisure time then takes place during the evening hours.

- A second approach to reduce fatigue in the midnight watch is to allow one crew member to work most of the night by extending the watch duration to five or six hours (e.g., Mid-0600). For this to work, the night watchstander must be allowed to retire prior to sunrise and sleep seven to eight uninterrupted hours in a dark and quiet environment with <u>absolutely no interruptions.</u> Allowing for one watchstander to cover the entire night watch avoids the need to adapt other personnel to night work. For nights, seek personnel who prefer to work at night.

- A third approach is to reduce the duration of the nighttime watch (e.g., three hours) to minimize the impact of fatigue on safety.

- Unwanted exposure to daylight may be minimized by wearing dark sunglasses. very dark sunglasses may be ordered from commercial sources. If these are not available, conventional sunglasses should measurably reduce light exposure.

- For exercise and meal recommendations, see the preceding page on “Adaptation to the Night Watch”.

CAFFEINE AND READINESS

3.5 Caffeine and Readiness

3.5.1 Overview of Caffeine

In this section you will learn:

- the problems caused by consuming too much caffeine;
- the safe way to use caffeine as a stimulant; and
- how to break an addiction to caffeine.

3.5.2 Caffeine: Alertness Boost or Endurance Drain?

Many (if not most) people in our culture are addicted to caffeine. We consume multiple servings each day through coffee, tea, soft drinks, and chocolate. While caffeine is classified as a stimulant drug, regular use of caffeine leads to ***reduced*** endurance. Caffeine actually ***drains*** energy when consumed on a daily basis. In high doses it can cause the "jitters" and anxiety.

For caffeine to be used as an alertness boost, it must be consumed at low levels and ***only when needed.*** Since the stimulant effects of caffeine last about three to four hours after consumption, time your caffeine consumption so that it will give you the alertness boost when you need it, and not interfere with sleep periods.

How to Use Caffeine as a Stimulant

- ❑ Avoid the habit of daily, frequent caffeine consumption.
- ❑ Avoid caffeine within four hours of bedtime.
- ❑ Use caffeine to boost alertness, but only when necessary.
- ❑ If caffeine is regularly needed to maintain alertness during duty hours, consult your physician.

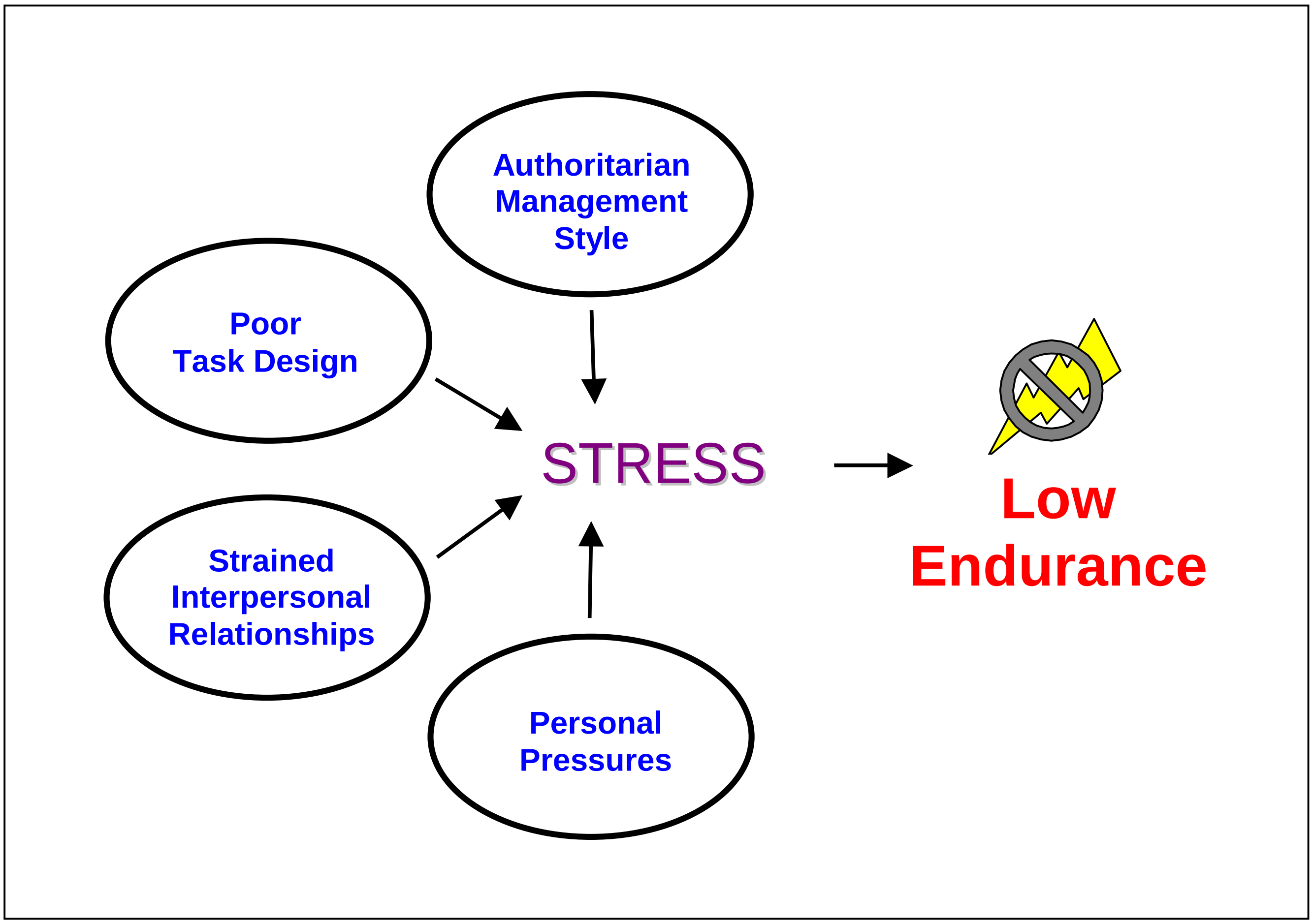
3.5.3 *Breaking an Addiction to Caffeine*

As just stated, in order to use the stimulant properties of caffeine successfully, one must consume caffeine only when needed as an alertness boost. For many of us, this means we need to break our addiction to caffeine and substitute non-caffeinated beverages for snacks and at meals. Withdrawal from caffeine takes about two weeks and is associated with some temporary, slightly unpleasant side-effects. So demonstrate that Coast Guard “can do” attitude, and soon you’ll be over the hump and feeling better than before.

Withdrawal from Caffeine

- ❑ Withdraw from daily caffeine use if possible; the withdrawal process may take two weeks.
- ❑ Withdrawal effects may include headaches, attention deficit, fatigue, and lack of motivation.
- ❑ Sleep patterns, however, may begin to improve within this period.
- ❑ Vigor and alertness after awakening may not be restored until the withdrawal process is complete (individual differences).
- ❑ After withdrawal, use caffeine only when needed to boost alertness.
- ❑ If total withdrawal is not desirable, reduce the consumption of caffeine to one serving (beverage, pill, or substance such as chocolate) per day.

STRESS


Authoritarian Management Style
Poor Task Design
Strained Interpersonal Relationships
Personal Pressures
STRESS
Low Endurance

3.6 Stress

3.6.1 Overview of Stress

This section discusses:

- factors that contribute to high stress levels;
- how stress affects the body;
- how stress robs us of energy and lowers endurance; and
- how to control stress.

3.6.2 Work Factors that Increase Stress and Sap Energy

Stress is a part of daily life. While a little bit of stress actually improves performance, too much stress depletes our energy resources, causes low endurance, and distracts us from primary tasks. The following factors can increase stress to levels that will compromise crew safety and performance:

<u>An Authoritarian Management Style:</u>
- lack of participation by workers in decision making
- poor communication between management and employees
- lack of family-friendly policies

<u>Poor Task Design:</u>
- high workload
- infrequent rest breaks
- long work-hours
- shiftwork (work outside of normal daytime hours)
- hectic routine tasks
- little sense of control

<u>Strained Interpersonal Relationships:</u>
- lack of support from coworkers and supervisors
- conflict with others (on or off the job)
- marital problems and divorce

<u>Personal Pressures</u>
- work-family conflict
- child or elder care
- few friends
- financial problems
- continuing education

These factors increase stress levels and use up energy, even during rest periods. Because of the energy-depleting effect of stress, we need to understand how to manage stress.

3.6.3 What Happens When We Get "Stressed"?

Humans have an inborn response to stress that is millions of years old. It is sometimes called the "fight or flight" response. Whenever we are faced with stress – be it physical, mental or emotional, life-threatening or not – it triggers the release of adrenaline, a hormone which causes a number of physiological reactions:

- heart rate increases,
- blood pressure increases,
- breathing becomes shallower and more rapid,
- blood flow is shunted to the muscles, and
- energy is released in preparation for fight or flight.

Prehistoric humans evolved this response to stress because, back then, most sources of stress required an intense, physical response (i.e., kill your attacker or run like heck). Today, most of our stresses are *not* life-threatening, and the physiological reactions triggered by the release of adrenaline are not adaptive and are even dangerous to our long-term health (chronic stress is believed to be one cause of cardiovascular disease). This is why learning to manage stress is an important skill in today's world.

3.6.4 Stress Decreases Endurance

How does stress affect endurance? Stress causes the release of energy. Chronic stress causes a constant drain on our energy stores. Similar to a house that leaks heat during winter, stress turns crew members' bodies into energy-leaking homes. The energy used in response to stress reduces the amount of energy we have for our work. This means, in stressful environments, we must produce even more energy in order to have enough to do our jobs. But stress actually inhibits our ability to produce energy: it prevents us from achieving a deep, restorative sleep. Thus, by wasting energy through our natural responses to stress, and by preventing the body from fully restoring itself during sleep, chronic stress chips away at our endurance.

FACT: The body's response to any life stress, life-threatening or not, involves energy expenditure and disruption of energy-producing activities during rest periods. Even during sleep, stress simply robs us of needed energy by disrupting the quality and duration of sleep.

In a stressful work environment, crew members can be expected to have difficulty in enduring physical and mental challenges. They may experience frequent bouts of reduced mental concentration and situational awareness, both undesirable states of mind in safety-sensitive jobs. The chronic use of over-the-counter stimulants (e.g., caffeine and pseudoephedrine) can result in decreased attention, irritability, and adverse health effects.

The implementation of adequate methods of stress management is a ***must-do*** for effective endurance management. This is particularly relevant in the Coast Guard, where high-tempo operations may provide personnel little or no opportunity to break away from work-related duties. Under these conditions, work-related factors such as task design, management style, and interpersonal relationships can easily induce chronic stress if not adequately managed. Identifying and reducing these causes of stress, as well as providing access to stress-reducing activities (e.g., exercise, recreation), will help to control stress and increase endurance. Stress reduction and morale boosters (such as access to cell phones or e-mail to keep in contact with family while at sea) can reap big pay-offs for a relatively small investment.

3.6.5 How To Control Stress

Education and awareness are important elements of any stress management program. Many of our personnel are not aware of the symptoms and consequences of stress. Compounding the problem, most people believe stress is an individual problem that must be handled at the individual level. Individual stress affects the entire unit, and people need to be aware of resources to assist in managing stress. The command and department heads have a critical role in implementing a successful stress management program. Components of a stress management program include:

- identifying stress management resources (e.g. wellness programs, financial advice, etc.)
- offering training in stress management, time management, and work planning,
- making time for exercise, recreation, and relaxation,
- promoting participatory troubleshooting and decision making,
- maintaining good working relationships,
- allowing for contact with family and friends (e.g., cell phones and email), and
- providing nourishing meals.

The recommendations on the next page provide a well-rounded list of ways to control stress and keep crew endurance high.

STRESS CONTROLS

- Train employees new to their job situation, particularly those recently promoted, to implement:
    - Time management strategies
    - A regular exercise program
    - Relaxation exercises (needed to reduce anxiety, increase concentration, and optimize quality of rest periods).
- Provide access to a variety of exercise equipment (e.g., free weights, stationary bicycles, rowing machines).
- Provide access to stress-reducing activities (e.g., provide satellite TV, provide relaxation exercise training, implement a nap policy during long work days, provide mental and physical health counseling).
- Promote crew participation in problem solving. Always use a team approach to solve problems. The process of participation reduces the feeling of alienation and promotes feelings of self-worth. It allows individual crew members to become part of a network.
- Identify and reduce stressors, particularly those involving interpersonal relationships.
    - Maintain good communication with crew members, realizing that alienation, withdrawal, and lack of participation are signs of stress.
- Modify the daily menu so that meals are balanced and offer plenty of fresh vegetables, fruits, whole grain breads, and low-fat meats such as turkey, fish, and chicken. Avoid fried foods, and favor broiled, grilled, and baked meals. Good food promotes high morale.
- Provide a variety of nonalcoholic, caffeine-free beverages and avoid the use of high-sugar soft drinks. The best drinks for our bodies are fresh water and fresh fruit juices.
- Provide access to family and friends through email or cell phone.

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COLD-RELATED ILLNESS

3.7 Cold-Related Illness

3.7.1 Overview of Cold-Related Illness

In this section you will learn:

- how exposure to cold temperatures reduces endurance;
- the symptoms of three cold-related illnesses: frostbite, trench foot, and hypothermia; and
- how to prevent cold-related illness.

3.7.2 Cold Temperatures = Lower Endurance

When the temperature falls, cold-related hazards rise. Prolonged exposure, even to mild temperatures, causes the body to work harder to maintain its core temperature. That means more of our energy resources are being shifted to survival needs, making less energy available to do our work. Our skin is an excellent radiator of heat, so we must take care to wear appropriate clothing (don't forget your hat and gloves!) in cool and cold weather. As skin temperature decreases, the temperature inside our extremities decreases as well, reducing muscle dexterity and coordination. Sensations of tingling and numbness are danger signals that should not be ignored. Continued exposure to cold can lead to hypothermia, with its mental confusion and disorientation, and ultimately to death.

WARNING! Cold weather threatens crew members' health and endurance particularly while working in unprotected areas where cold exposure can result in extreme reduction of body temperature (hypothermia) and severe frostbite of hands and feet.

3.7.3 Use Common Sense on Deck

Lack of common sense on deck is a primary endurance risk factor. Cool high winds, dampness, and cold water -- all readily available on the decks of CG cutters and small boats -- can cause cold-related illness. In these environments crew members must be aware of a number of risk factors that will combine to threaten their health and endurance:

- Wet clothing
- Insufficient insulation of body, head, hands, and feet from wind, ocean spray, and cold temperature
- Use of medication that disrupts the body's ability to regulate core body temperature
- Physical exhaustion
- Age--the older we are the greater the danger to succumb to cold-related illness
- Prolonged work related exposure to cold, windy, and wet environments allowing numbness of fingers and toes to set in

3.7.4 Cold-Related Illness

Exposure to cold can result in:

- **Frostbite** (skin tissue freezes at 30 °F). Fingers, cheeks, nose, and ears are most susceptible. Symptoms include sensation of coldness, tingling, stinging, aching, and numbness. Untreated, this condition can result in amputation or loss of function of affected area. First aid requires treating tissue with warm water (102-110 °F) as long as there is no chance for re-freezing tissue. Bed rest and medical attention must follow first aid.

- **Trench foot** (long exposure to wet and cold). This results in damage of the circulatory system. Symptoms include tingling, itching, swelling, and pain. Untreated this condition can result in death of skin tissue and ulceration. First aid requires moving crew members to warm area, treating the foot or feet with warm water (102-110 °F) or warm packs. Bed rest and medical attention must follow first aid.

- **Hypothermia**. Environmental air temperatures of 50 °F and below, or water temperatures of 72 °F and below can induce persistent loss of body heat. Symptoms involve shivering uncontrollably, confusion, carelessness, and disorientation. Untreated this condition can result in death. First aid requires moving crew member to warm and dry environment, removing wet clothing, offering warm nonalcoholic drinks, and using warm blankets to insulate body from further cold exposure. Bed rest and medical attention must follow first aid.

Controlling Cold-Related Endurance Risk Factors

Train crew members to:

- Wear 3-layered warm clothing. The first or outer layer breaks the effects of wind chill. Gore-Tex and nylon materials are best. The second or middle layer absorbs sweat and insulates the body from the external cold. Wool and synthetic-pile are best for this use. Lastly, the innermost and third layer must provide ventilation and the escape of perspiration. Cotton and synthetic fibers are best inner layer materials.
- Bring sufficient change of clothing to prevent working with wet garments.
- Keep the head covered at all times. Most body heat is lost when the head is unprotected from cold.
- Maintain hands, feet, and face covered and warm. Fingers and hands can't function properly below 59° F.
- Keep feet well insulated from cold and dampness. Layered socks and insulated boots are a must.
- Keep garments clean. Soiled clothing looses its insulating properties.

Provide Crew members with:

- A heated shelter
- Protected work areas
- Radiant heaters
- Thermal insulating materials placed over handles at environmental temperatures below 30° F
- Extra breaks for crew members exposed to cold environments (deck personnel)
- Reduced work pace
- Training session on how to endure cold-related risk factors.

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Heat Illness

3.8 Heat Illness

3.8.1 Overview of Heat Illness

In this section you will learn:

- how hot temperatures affect the body and pose an endurance risk;
- the symptoms of heat exhaustion and heat stroke; and
- how to prevent heat illness.

3.8.2 Heat is an Endurance Hazard

Aboard cutters, exposure to hot environmental temperatures are common on deck during the summer months; but engineering spaces are areas of extreme heat year-around. Dehydration and loss of minerals needed to maintain body functions are constant risks to crew endurance.

> **WARNING! Heat illness is caused by prolonged exposure to heat and insufficient fluid intake.**

Normally, when we are exposed to heat, our bodies maintain the core temperature (98.6 °F) by sweating. The evaporation of sweat from the skin acts to cool the skin. Prolonged exposure to heat (which can be compounded by strenuous physical activity and-or insufficient intake of water and salt) can overwhelm the body's ability to cool itself, leading to the acute onset of heat illness. Depending on the degree of severity, heat illness is classified as heat exhaustion or heat stroke.

3.8.3 Heat Exhaustion

Heat exhaustion typically occurs when people exercise heavily or work in a warm, humid environment where body fluids are lost through heavy sweating. Fluid loss can result in a decrease of blood flow to vital organs. In heat exhaustion, sweat does not evaporate as it should, possibly because of high humidity or too many layers of clothing. As a result, the body is not cooled effectively.

The symptoms of heat exhaustion are:

- Pale, clammy (cool and moist) skin
- Heavy sweating
- Dilated pupils
- Headache
- Nausea or vomiting
- Dizziness

3.8.4 Heat Stroke

Heat stroke is life-threatening. The body's ability to regulate its temperature has broken down, and unless first aid is given, body temperature will continue to rise, causing brain damage and death. Heat stroke requires medical attention.

The symptoms of heat stroke consist of several or all of the following:

- Hot, red, dry skin (unless still damp from earlier perspiration)
- Constricted (very small) pupils
- High body temperature (sometimes as high as 105 °F)
- Confusion, disorientation
- Loss of consciousness

EMERGENCY! Should a person exhibit heat illness symptoms, use a cold water bath or cold wet sheets to cool her/his body temperature. If the person is conscious, give one-half glass of water every 15 minutes. Transport person to the nearest hospital immediately.

WARNING! Crew members suffering from any illness that results in fever, vomiting, or dehydration will be more susceptible to heat illness.

Prolonged exposure to heat depletes the body of water and salt. Heat exhaustion is inevitable if crew members do not maintain an appropriate amount of water and salt intake during their exposure to extremely hot environmental temperatures. Continued exposure to hot environments will result in the breakdown of the body's ability to regulate core body temperature. Under these conditions, heat stroke will be induced when the body approaches temperatures of about 105-107 °F.

FACT: Acclimatization, the process of adaptation to heat exposure, can be achieved by a minimum of sixty to ninety minutes of exercise or strenuous work in the heat each day for one to two weeks. Adaptation begins to occur within a few days.

How to Prevent Heat Illness

Train crew members to:

- ❑ Drink water often; do not wait until they are thirsty.
- ❑ Drink extra water if they are sweating heavily (can't make sweat without water). Begin each work period by drinking approximately one pint of water. Water is best consumed in volumes of no more than ½ pint (1 cup) at a time.
- ❑ Drink extra water if urination becomes less frequent than normal or if urine's color becomes darker.
- ❑ Replace electrolytes with commercial sports drinks that contain 6% glucose and 10-25 mEq/L of sodium. Most commercial sports drinks contain these proportions. Another way to replace electrolytes is through salt obtained from regular meals and snacks.
- ❑ Seek well ventilated places.
- ❑ Wear loose fitting clothes of light colors.
- ❑ Avoid the use of alcohol or drugs that may impair temperature regulation.
- ❑ Acclimate to hot weather as much as possible before embarking on long work-hours.
- ❑ Take rest breaks -- frequent, short exposures vs. long exposures.
- ❑ Keep cool by drinking cool fluids or wearing an ice vest.
- ❑ Schedule work for cooler times of the day.
- ❑ Improve physical fitness.

MOTION SICKNESS

3.9 Motion Sickness

3.9.1 Overview of Motion Sickness

This section will discuss:

- what causes motion sickness;
- how motion sickness creates an endurance risk; and
- controlling motion sickness: medications and their side effects.

3.9.2 Misery and the Adaptation Process

Motion sickness is induced through an internal conflict in the brain created by external visual and movement stimulation.   Standing on firm ground, the brain senses our body's position (e.g., upright, upside down, or horizontal) relative to the ground. This sensory pattern becomes coded in memory (as a template) and it is updated constantly.

However, when we are on a moving platform, at first, the information stimulating our sensory systems does not match with the existing memory template. This mismatch creates a series of changes in our physiology as the brain tries to create a new memory template. We experience these changes in terms of "cold sweats," yawning, fatigue, dizziness, headaches, nausea, and vomiting.

Fortunately, a new template is formed through constant exposure to ship motion. We eventually get our "sea legs," but often not until we've spent several days of misery suffering from motion sickness symptoms. Some people adapt quicker than others; yet, some never do adapt sufficiently to feel well enough to work.

WARNING! Motion sickness induces fatigue and deteriorates performance. Crew members experiencing symptoms should sleep as much as possible, but always walk around some of the time to help the brain expedite adaptation. Safety is at risk when crew members encounter motion sickness because fatigue and drowsiness are experienced until the brain adapts to the moving environment.

3.9.3 Magic Bullets, Performance, and Safety

Medications used to alleviate the symptoms of motion sickness or to prevent its onset usually have side effects that cause either severe drowsiness and/or fatigue. A list of medications and their side effects are provided below (see Table 3-6). It is recommended that crew members receiving medications to mitigate the effects of motion sickness be warned that performance will inevitably degrade. Department heads need to keep in mind that crew members receiving medications should not be involved in tasks that may endanger their safety or that of others. If at all possible, crew members receiving motion sickness medication or experiencing severe symptoms should avoid shipboard work environments. We strongly recommend that the ship's medical officer closely supervise crew members using these medications. Self-administration and self-supervision is discouraged.

Table 3-6. List of medications commonly used to fight the symptoms of motion sickness. Note that Scopolamine is the only medication that may help speed the process of adaptation.

MEDICATION	USE	SIDE EFFECT
Scopolamine Patch	Speeds adaptation within 72 hours	Drowsiness Degrades vision
Dramamine	Reduces symptoms	Drowsiness
Antivert	Reduces symptoms	Drowsiness
Phenergan	Reduces symptoms	Drowsiness
Amphetamines	Reduces drowsiness	High blood pressure Disrupts heart rate Addictive
Ephedrine	Reduces drowsiness	High blood pressure Disrupts heart rate Addictive

4 PUTTING IT ALL TOGETHER: DEVELOPING A WORKABLE CREW ENDURANCE MANAGEMENT SYSTEM

4.1 Overview of Section 4

You've discussed the crew endurance risk factors with your personnel and determined that one or more of them apply to your unit. Now what? This section provides details on how to design and implement a crew endurance plan. While it is unrealistic to expect rapid and dramatic changes in any organization, it is feasible to expect endurance improvements from gradual changes that do not threaten operational efficiency.

This section will show you how to:

- use the crew endurance management model to identify the types of changes your unit can make to improve crew endurance;
- develop a crew endurance plan by using Section 3 to identify controls for your unit's specific endurance risk factors;
- implement and evaluate your crew endurance plan.

The methods discussed here are not "theory": they are practical, workable methods that have been successfully implemented and proven at various Coast Guard units. Woven throughout this section will be a real example of how a crew endurance plan was developed and implemented on a Coast Guard cutter. If they can do it, *you* can do it.

4.2 The Three Phases of Crew Endurance Management

To review from Section 2, there are three phases to the successful management of crew endurance:

Phase I – Initial Evaluation

- Form a crew endurance Working Group
- Conduct a Crew Endurance Risk Assessment
- Measure crew endurance under your current operations
- Develop a crew endurance plan

Phase II – Implementation

- Implement the crew endurance plan

Phase III – Follow-up Evaluation

- Evaluate the effectiveness of the crew endurance plan
- Periodic reassessment and continuing education

The steps in the Phase I evaluation are aimed at identifying the crew endurance risk factors relevant to your unit. Further, Phase I seeks to understand how your unit's policies and operational environment contribute to these risks so that the Working Group can devise alternative strategies to improve endurance. In Phase II these strategies are implemented, followed by a formal evaluation and periodic education and reassessment in Phase III. Successful crew endurance management is an ongoing process.

4.3 Phase I – Initial Evaluation

4.3.1 Forming a Working Group and Conducting the Crew Endurance Risk Assessment

Section 2 described the first two steps of Phase I, namely forming a Working Group and conducting a crew endurance risk assessment; these steps will be discussed only briefly in the current section. This section will provide more details and examples on endurance plan development and implementation. If you haven't already done so, please read Section 2 to get an overview of these steps before proceeding further. Below is some introductory information about our cutter example.

4.3.1.1 Cutter Example: Forming a Working Group and Conducting a Crew Endurance Risk Assessment

USCG Cutter X was very enthusiastic about, and committed to, improving crew alertness. Their Working Group was led by the CO and included the XO, the department heads, and select crew members. The Working Group received an educational workshop from the R&DC, including information on the topics in this *Guide.* Their biggest problems were getting sufficient sleep:

- Their crew was on a rotating schedule and finding it difficult to adapt to the frequent schedule changes.
- They were aware of some sleep environment problems and had already minimized the use of pipes in order not to disturb sleep. But early morning training and berthing cleanups also prevented night-watch personnel from obtaining sufficient sleep.

4.3.2 Measuring Crew Endurance Under Current Operations

While the Crew Endurance Risk Assessment Form is a good tool to identify many of the more obvious endurance risks, there may be additional situations or environmental factors that may be overlooked. For units with the resources and desire to take a more in-depth look at crew endurance, a formal evaluation is recommended. This evaluation would document crew duty hours, workload, and rest associated with both low- and high-tempo operations over a 15-30 day period. The R&DC has had great success employing such evaluations at CG units, and is in the process of developing streamlined tools to facilitate similar data collection and analysis by field units. These tools will be included in the next version of this *Guide*.

4.3.3 Developing a Plan to Control Crew Endurance Risk Factors

Before beginning this step, the Working Group should have:

- read and understood this *Guide*;
- completed the Crew Endurance Risk Assessment;
- analyzed the results of the risk assessment to prioritize the unit's crew endurance hazards.

The results of the risk assessment (for different departments and under different operational conditions) pinpoint the types of crew endurance hazards that exist in your unit. The next step is to consider the types of controls (discussed in detail in Section 3) that can be implemented to reduce or eliminate the endurance hazards. But how do you select from the many controls available? One useful starting point is to consider the crew endurance management model to determine where endurance improvements can be made without sacrificing mission objectives.

4.3.3.1 The Crew Endurance Management Model

As we've seen in Section 3, there are a variety of interrelated factors that affect crew endurance. Making changes in any one area is likely to have a "trickle down" effect on other areas. For example, during the transfer season, many units are suddenly lacking experienced, qualified personnel. This often necessitates longer work hours for the remaining experienced personnel to ensure qualified members are standing watches and to train new staff. These changes are likely to result in shorter duration sleep acquired by personnel (due to longer working hours) and a disrupted body clock (due to changing the watch rotation from a 1-in-6 to a 1-in-5 or 1-in-4). This shows how one area (in this case, the CG policies affecting the frequency and timing of personnel transfers) can have wide-ranging effects on other areas (e.g., number of qualified personnel, watch schedules, work hours, crew endurance, and unit readiness). We call this larger view of interrelated factors a "systems approach."

The crew endurance management model embodies a systems approach to understanding crew endurance, and it can help us to develop a crew endurance plan for our unit. There are four areas to consider when designing controls to improve crew endurance (see Fig. 4-1):

- mission objectives;
- personal endurance plans;
- duty cycles and training; and
- collateral duties and environmental attributes.

This model first considers the mission of the unit and what variables or characteristics of the unit ***cannot*** be modified (because it would negatively impact mission effectiveness). The model then considers three “layers” of potential crew endurance controls. The personal endurance plan encompasses things the individual can do to ensure the best possible endurance. The duty cycles and training layer of the model encompasses such things as watch schedules, patrol schedules, and improving sleeping quarters. These variables are under the control of the command staff and directly support (or detract from) personnel's ability to endure. Finally, the collateral duties layer considers the prioritization and scheduling of collateral duties, and other environmental variables (such as exposure to extreme temperatures, ship motion, noise, etc.). Again, these are under the control of the command staff, and tend to be the easiest changes to make, as they have little or no direct impact on the mission objectives. The outer two layers are the most flexible and will probably be where most of the improvements will be made.

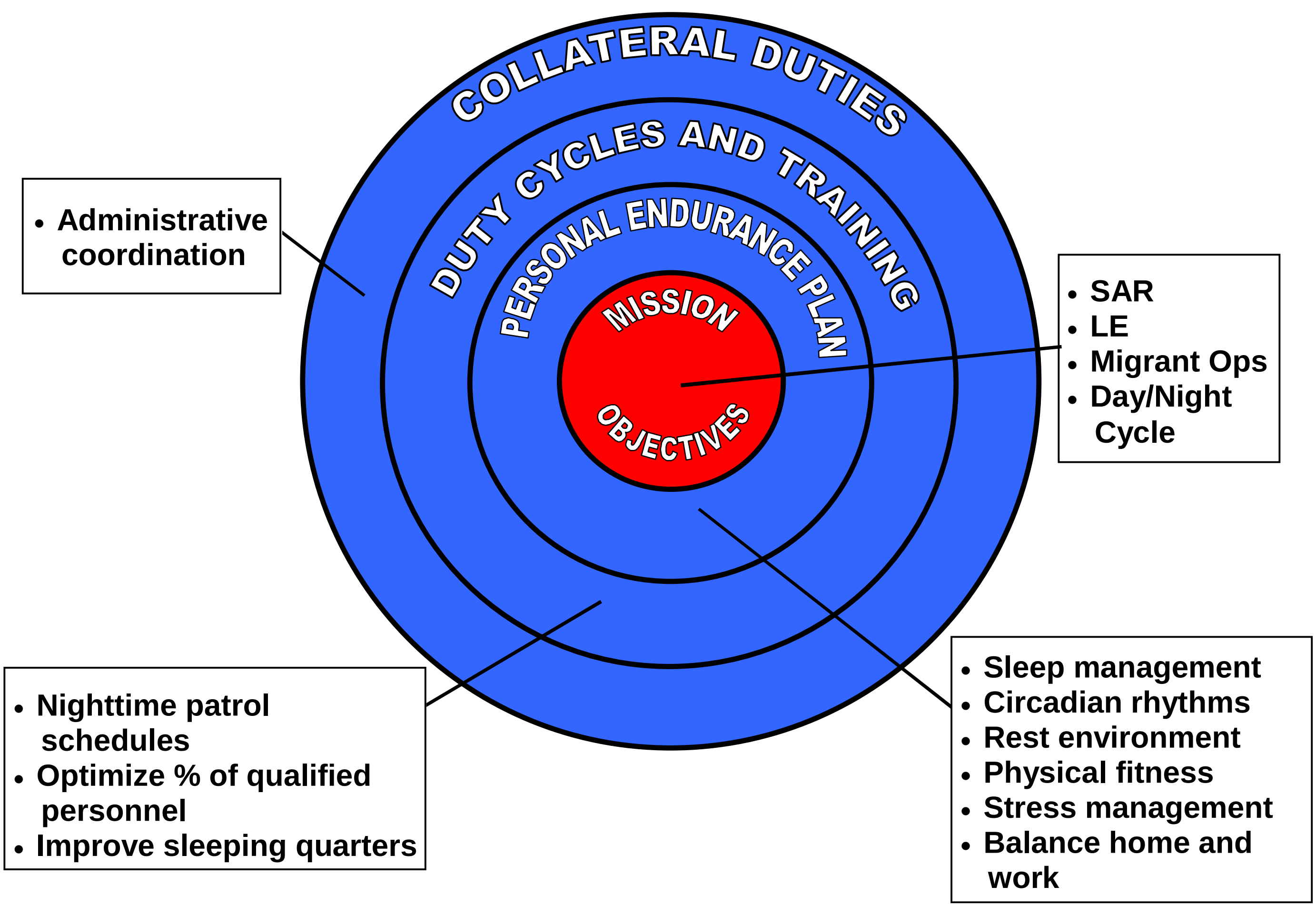

Figure 4-1. Crew endurance management model.

4.3.3.2 Mission Objectives

Mission objectives (the "bulls-eye" in Fig. 4-1) are at the center of the model because they form the heart of the unit's purpose. As the diagram shows, Coast Guard mission objectives may be Search and Rescue, Law Enforcement, Migrant Interdiction, etc. Mission objectives are a "requirement": they are not subject to change, and any controls put into place must not undermine the mission objectives. Usually, a successful crew endurance plan will enhance the unit's ability to complete their missions.

4.3.3.3 Personal Endurance Plan

The second layer in the crew endurance management model is the personal (individualized) endurance plan for each member of the unit. This layer offers a little flexibility, but it is constrained by the relative rigidity of our human physiology. As we've discussed in detail in Section 3, the human body needs 7-8 hours of consolidated sleep, nutritious foods, and exercise in order to function properly. And while the body clock can be coaxed to adapt to nighttime duty, there are significant demands (e.g., light management, sleep and nap requirements) that must be met in order to do this effectively. The success of these individual efforts depends on command and department head support (the outer two layers) and alignment with the mission objectives (center layer).

It is understood that operational requirements may interfere at times with the perfect execution of a personal endurance plan. For example, a SAR case may disrupt sleep from time to time. However, obtaining seven to eight hours of good quality sleep in five of seven consecutive days will go a long way in the maintenance of endurance. While the "personal endurance plan" layer must accept constraints imposed by operational requirements, it clearly prescribes the observance of endurance limits imposed by physiological and psychological requirements. Thus, management staff and personnel must understand that to endure job-related challenges, it is necessary to consume a healthy diet, maintain a consistent individual exercise program, manage stress, manage sleep and the body's clock, as well as limit exposure to environmental stressors such as extreme temperatures, noise, and vibration. Section 3 provides specific controls for these endurance risk factors.

4.3.3.4 Duty Cycles and Training

Duty cycles and training, plus enabling actions, constitute the third layer of the crew endurance model. This layer, controlled by the command and department heads, must support personnel's efforts to maintain endurance. The policies and procedures that make up this layer have a direct influence on both the personal endurance plan and the missions objectives. Good examples of crew endurance organizational support include the following actions:

- The analysis of tradition-driven events that may adversely impact endurance. For example, on several CG cutters, limiting the use of loudspeakers between 1800-1000 and not piping reveille have been shown to improve the duration of crew members' sleep. Similarly, berthing area cleanups can be done in the afternoon, rather than in the morning when night workers are trying to sleep.
- Policy changes, such as promoting napping under certain situations (see napping guidelines in Sec. 3.3).
- Modifications to sleeping quarters, such as the use of light-blocking curtains and sound insulation, will directly support personnel's efforts to obtain good quality sleep.
- Improvements to leisure facilities and access to exercise equipment offer stress reduction, better health, and improved morale.
- The modification of watch schedules to optimize crew rest and avoid chronic sleep loss will increase endurance (details in this section).
- Instituting light management through increased lighting in operational spaces (when mission-appropriate) to improve alertness (see light management suggestions in Sec. 3.4.6).
- The implementation of shipboard crew endurance training for both management staff and personnel.
- Coordination of the ship's or unit's routines (e.g., briefings, planning sessions, meal schedules, training schedules) to prevent disruption of rest periods.
- The design of meal menus with frequent entrees of broiled or grilled chicken, turkey, and fish, as well as vegetables and low-starch foods, will help maintain an energy-efficient diet. Reduction of fried foods and high-sugar snacks will also improve energy efficiency and availability.
- The dissemination of nutrition information will help personnel to make the right choices.

Ultimately, the command and wardroom/department heads should agree on supporting the implementation of a plan that includes modifications to watch schedules, sleep and light management schedules, crew endurance education for all personnel, and plans that optimize sleep and maintain the timing of the biological clock.

4.3.3.5 Collateral Duties and Environmental Aspects

The outer layer of the crew endurance management model consists of elements that are only indirectly related to the mission; however, changes in this area can have profound effects on the personal endurance plan, and thus, on the unit's crew endurance. These elements include collateral duties and environmental hazards. The timing of collateral duties should not interfere with personnel's sleep schedules. Environmental hazards, such as motion sickness and extreme temperatures, are sometimes unavoidable. However, personnel can be trained on how to prepare for and lessen the effects of such hazards, leading to better endurance.

4.3.4 Developing a Crew Endurance Plan

Developing a crew endurance plan involves taking the high-priority risk factors you identified in the Crew Endurance Risk Assessment, and selecting controls from Section 3 that will be both workable in your situation and that will not interfere with your unit's missions. Using the crew endurance management model as a guide, which controls would be relatively easy to implement (outer layers)? Relatively small changes, such as eliminating "pipes" and improving sleeping quarters, can have very beneficial effects. Some changes, such as instituting new watch schedules or a napping policy, may meet with some resistance at first, but can reap large endurance rewards.

Try to plan controls that will eliminate or mitigate as many of your high-priority hazards as possible. To best organize this information for review and presentation, make a table of all the risk factors, the possible controls you have identified to manage the risk, and whether the controls(s) can be implemented immediately, short-term (6-12 months), or long-term (>12 months). Also, if appropriate, list any constraints that may limit the use of the control(s). An example is shown in Table 4-1.

Table 4-1. Sample Crew Endurance Plan Format.

Endurance Risk	Control(s)	Time to Implement	Constraint(s)
Poor quality sleep	• Reduce pipes • Change work schedules • Insulate berthing spaces	• Immediate • Immediate – 6 months • 6-12 months	• None • Insufficient qualified personnel • Expense
No exercise	• Provide PT time • Purchase equipment	• Immediate • Immediate – 6 months	• None • Expense

There is apt to be some lively discussion about the pros and cons of various potential "improvement" suggestions. Working Group members are urged to keep an open mind: none of us enjoy making changes, but some types of change will be necessary if we are to improve crew endurance.

Once the Working Group has developed an endurance plan for the unit, it is useful to discuss elements of the plan with other personnel to ensure the plan will not be harmful in any way to mission accomplishment. This is particularly important when the Working Group does not have representation from all departments in the unit. It is also a good idea to apply the risk assessment checklist to the new endurance plan as a double-check that the new plan does not inadvertently introduce any new risks.

MANAGEMENT NUGGETS: Crew Endurance Management requires the development of work and rest management plans (and enabling actions) that optimize alertness and performance during duty hours. This goal is accomplished by:

- forming a ship/unit Working Group (if possible) to coordinate training, document crew rest during the implementation of new work schedules, and support the overall implementation of crew endurance practices;
- providing information to department heads on how to design and implement work schedules that both meet the operational objectives of the vessel and maintain a stable body clock;
- providing information to personnel on how to maximize the benefits of rest opportunities; and
- implementing crew rest evaluations that document: 1) the timing and number of rest opportunities available for crew members, and 2) crew members' commitment to taking advantage of rest opportunities.

4.3.4.1 Cutter Example: Developing a Crew Endurance Plan

The watch schedules aboard the cutter were modified to promote body clock stability by keeping sleep/wake times stable and by providing a longer period for uninterrupted sleep. Most departments implemented either a one-in-six schedule or a modified one-in-three (Table 4-2). The modifications to the one-in-three consisted of a

Table 4-2. Comparison of a standard 1-in-3 watch with the cutter's improved four-section watch schedule. (The duty sections are labeled A-D.)

Standard 1-in-3				Improved Watch Schedule			
	Day 1	Day 2	Day 3		Day 1	Day 2	Day 3
0000-0400	A	B	C	0000-0300	A	A	A
0400-0800	B	C	A	0300-0600	B	B	B
0800-1200	C	A	B	0600-0900	C	C	C
1200-1600	A	B	C	0900-1200	D	D	D
1600-2000	B	C	A	1200-1500	A	A	A
2000-0000	C	A	B	1500-1800	B	B	B
				1800-2100	C	C	C
				2100-0000	D	D	D

reduction of the watch duration from four to three hours, going from three watch sections to four, and in the fact that crew members were permanently assigned to a specific schedule (i.e., their schedules did not rotate). Thus, crew members had the opportunity to develop consistent sleep schedules and had nine consecutive hours off in which to get sleep. This schedule was used in the Deck, Operations, and Support departments; unfortunately, Engineering did not have sufficient personnel to implement this schedule.

In addition to the watch schedule change, the cutter's crew endurance plan also included:

- To increase the number of day workers (so their body clocks can stay on a "day" orientation):
  - + helmsman/lookout watch was decreased to one person on watch; there are 8 qualified watchstanders; in a given week, four will be assigned as watchstanders, on the improved three-hour watch schedule (Table 4-2); there will be a duty helmsman available as needed;
  - + QMOW/BMOW has 5 qualified watchstanders; in a given week, four of them will stand the improved three-hour watch schedule (Table 4-2); the fifth person will be a day worker; the day worker assignment will rotate through personnel on a weekly basis;
- To enable all crew to get good quality sleep:
  - + created "pipe free" periods after 1945 until 1100 (unless emergencies or critical operations required ship-wide announcements)
  - + authorized Saturday late rack
- To enable night watchstanders to get good quality sleep in the morning:
  - + no reveille
  - + berthing area cleanups in the afternoon (vs. morning)
  - + training core hours shifted to 1015-1600

  - increased cross training so that additional (non-night-watch) personnel would be available for law enforcement and other operations, allowing night watchstanders to sleep
- To improve alertness on the job:
  - increased lighting to >1,000 lux in engineering
  - used light management for all crew (managing times of exposure to morning light and use of sunglasses to prevent exposure of night workers coming off watch)

4.4 Phase II – Implementation

This is the moment you've been waiting for, when all your hard work is about to pay off. Implementation of the new crew endurance plan includes:

- getting buy-in from all command staff and department heads;
- educating all personnel on the concepts of crew endurance, risk factors currently present in your operations, the crew endurance plan for controlling these risks, and each person's responsibilities within the crew endurance plan;
- implementing the crew endurance plan;
- monitoring the implementation process to identify and correct any problems.

Leaders at all levels of the organization must understand and actively encourage adherence to all facets of the new crew endurance plan. Especially if your unit is making significant organizational changes (such as instituting a napping policy or changing work schedules), leadership buy-in is essential. People are naturally resistant to changes -- even to changes that will benefit them -- so an engaged leadership is necessary to promote acceptance by personnel. The command and department heads create the infrastructure that can support the implementation of crew endurance management practices. They must, above all, master how to control crew endurance risks and create a collaborative network to facilitate the implementation of crew endurance management practices aboard ships and throughout the unit. Ultimately, leaders must teach, support, encourage, and lead personnel to the consistent practice of sound endurance strategies.

MANAGEMENT NUGGET: The successful implementation of new operational policies to improve endurance requires an aggressive education program designed to instruct the unit's command staff, department chiefs, and crew/personnel on their contributions to the coordination and execution of the various elements of the new endurance management plan.

Education is probably the most crucial component of implementing the crew endurance plan. People need to understand and embrace the concepts of crew endurance so that they will recognize how the elements within the crew endurance plan will benefit them. The best way to introduce crew endurance is to make it a topic at one or more unit safety meetings. In this way, the concepts can be taught to all hands, and the components of the new crew endurance plan can be discussed at length. Also, relevant sections of this *Guide* can be distributed to personnel so that they can review the information presented at the meetings and have a copy of the personal controls (e.g., sleep management, napping tips, caffeine usage, motion discomfort) as a reference.

Once your personnel are educated and ready to accept the new crew endurance plan, implement it. Depending on the number and types of changes you have planned, you may want to implement them in a phased approach, so that personnel can deal with a few changes at a time. Remember: change is stressful.

As you implement your plan, encourage all personnel to provide feedback on any negative consequences that appear. Sometimes, even with the best of planning, unforeseen problems arise, and the plan may need to be "tweaked". Once the plan is completely implemented and appears to be running smoothly, allow the unit to stay on the plan for at least one month before going to the evaluation step.

4.5 Phase III – Follow-up Evaluation

4.5.1 Evaluating the Crew Endurance Plan

How do you know whether your crew endurance plan is working? While a formal evaluation of the endurance of your personnel is beyond the present scope of this *Guide* (evaluation tools and guidance should become available in about a year), an informal assessment can be performed easily. The Working Group should talk to personnel about their subjective reactions to the crew endurance plan. Are they getting additional sleep, and is that sleep of better quality (i.e., fewer disruptions)? Do they have more energy on the job, and do night-watch personnel feel more alert? Have department heads seen any changes in performance? Asking these types of questions is a simple way to determine whether the crew endurance plan is having the desired effect. It is also a good way to identify unanticipated, negative consequences of the plan. Another method for getting a rough evaluation is to use the Crew Endurance Risk Assessment Form (Sec. 2.3.2). Have the number and-or frequencies of the risk factors decreased? Risk factors that still occur two or more times per week identify areas for continued improvement through additional modifications to the crew endurance plan.

Do not be disillusioned if you find only modest improvement: this process is usually iterative. Sometimes, crew members may not be getting sufficient sleep even though their watch schedules and the unit's training and other schedules have been modified appropriately. In these cases it may be that these individuals are not making responsible choices to get the sleep they need (e.g., they may regularly stay up late to watch TV and thus not get sufficient sleep). A discussion with personnel about the importance of maintaining good endurance and their responsibilities to manage their personal schedules may be of value.

The Working Group should continue to discuss endurance issues with personnel and identify additional variables that may be contributing to lower-than-desired endurance levels. Such analysis will lead to an improved crew endurance plan and satisfactory endurance levels for most personnel. Since Coast Guard service is 24 hours per day, 365 days per year, there will always be times when prolonged duty periods are necessary and endurance suffers temporarily; but if personnel can acquire good quality sleep for the majority of each week, that will go a long way to giving them the extra endurance to make it through the challenging times.

4.5.2 Periodic Reassessment and Continuing Education

The Coast Guard is a dynamic and evolving organization. That means that many units will see changes in their missions over time. When operational requirements change, the Working Group should consider whether these changes might impact crew endurance, and if so, seek adjustments to the unit's crew endurance plan. Even when the unit's mission stays relatively the same, it is a good idea to periodically reassess crew endurance to ensure that personnel are maintaining satisfactory controls over stressors and sleep needs. It is strongly suggested that the Crew Endurance Risk Assessment (Sec. 2.3.2) be performed periodically (every one to two years) to check whether crew endurance is satisfactory and to identify any new variables that may be reducing endurance. If the results appear unsatisfactory, then modifications to the crew endurance plan are needed.

Annual refresher training on crew endurance is needed to remind personnel of the goals of the unit's crew endurance plan and their responsibilities within that plan. And, of course, any new members to the unit should be provided with education on crew endurance and the unit's crew endurance plan.

Following these steps will help you develop, implement, and monitor a successful crew endurance plan for your unit. Unit personnel will benefit by achieving better sleep, lower stress, better overall health, and higher energy. The unit will benefit by having personnel with more energy and enthusiasm for their jobs, better safety, and improved readiness and mission effectiveness.

4.6 Summary of Crew Endurance Management

The consistent use of the Crew Endurance Management process allows the unit's command, department heads, and crew members to use objective methods to constantly improve personnel endurance, and thereby mission effectiveness and safety.

This system does not prescribe specific schedules; rather, it provides a process to maintain endurance, prevent fatigue and burnout, and contribute to enhanced safety and effectiveness of overall operations. Unit command and Working Group members can become champions of the endurance plan aboard cutters, at air stations, and at shoreside units, and contribute to the maintenance of crew endurance Coast Guard-wide.

Further information on equipment, development, and implementation of crew endurance plans can be obtained by contacting Crew Endurance Team members at U.S. Coast Guard Headquarters' Office of Safety and Environmental Health (G-WKS; Dr. Tony Carvalhais, 202-267-2244), or the U.S. Coast Guard Research and Development Center in Groton, CT (Crew Endurance Team, Dr. Carlos Comperatore, 860-441-2751).

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Appendix A

SLEEP STAGES

Sleep is an active process, with a defined cycle of activity that progresses predictably throughout the sleep period (see Figure A.1 below). The brain activity that occurs during sleep is measured in five stages:

Stage 1 is the transition from wake to sleep. This stage is characterized by a slowing of brain activity compared to wakefulness. When aroused from this stage, many people believe they were never asleep. After about five to ten minutes of stage 1 sleep, the person progresses to a deeper sleep, stage 2.

Stage 2 is characterized by even slower brain activity than stage 1 and is considered by many to be the true onset of sleep. Within ten to 15 minutes, brain activity slows down even further and progresses into the deepest sleep, stages 3 and 4.

Stages 3 and 4 are termed slow-wave sleep (SWS). It may be very difficult to arouse a person from SWS, and once awake, the person may feel sluggish for several minutes. After 20 to 30 minutes of slow-wave sleep, brain activity reverts briefly back to stage 2 sleep, and is then followed by rapid eye movement (REM) sleep, or dream sleep.

Stage 5, REM or dream sleep, is characterized by quick eye movements, little to no muscle tone, and very active brain patterns. The first REM period of the night is relatively short, lasting five to ten minutes.

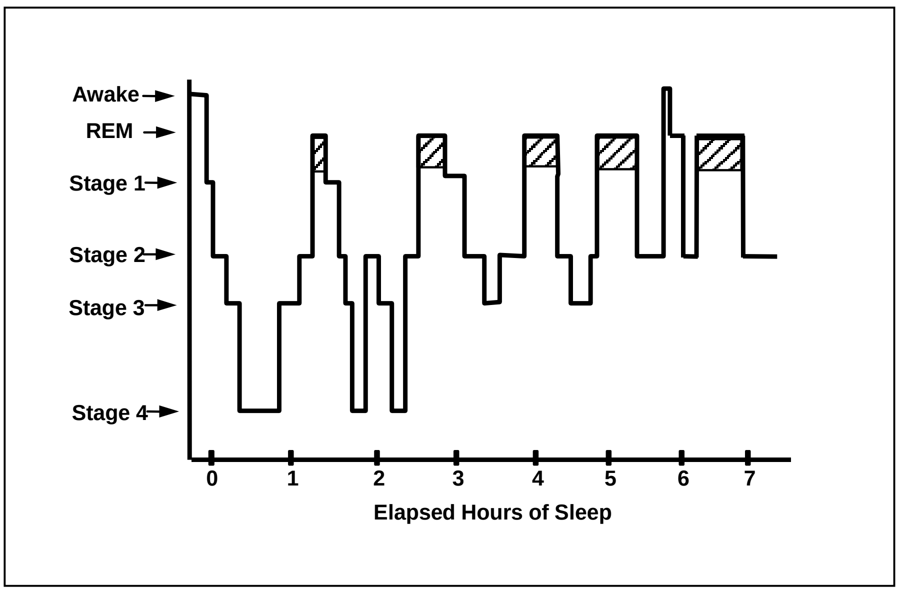

Figure A.1. Stages of Sleep.

After REM sleep, the sleep cycle repeats itself, returning to stages 2, 3, 4, and back to REM. Each cycle lasts approximately 90 minutes, with approximately five to six cycles occurring per night. Most SWS occurs during the first half of the sleep period, while most REM sleep occurs during the second half of the period. Overall, stage 2 sleep occupies the majority of the sleep period, followed by REM sleep, and then SWS. This cycle of sleep activity is important for personnel to acquire restful sleep. The cycle can be disrupted by schedule changes, frequent awakenings, medications, and so forth. When a significant disruption in this pattern occurs, personnel may not obtain restful sleep and will be fatigued the next day.

Appendix B

TRANSITIONING TO THE NIGHT WATCH

The purpose of this appendix is to recommend how to transition from a daytime schedule to a night work schedule, and vice versa. It is assumed that prior to switching to the new schedule, the individual has been working the current schedule (be it days or nights) for at least two weeks and is well-adapted to that schedule. It is further assumed that bright lights cannot be used in the work environment while on night duty. (If bright lights *are* in use at night, then refer to Sec. 3.4.6, *Light Management and Adaptation to the Night Watch.*)

The figures below suggest work-sleep-nap schedules to assist personnel during a transition to and from night watch schedules. Figure B-1 is for changing from a day schedule to a night schedule when the night schedule will cause your work period to end ***after sunrise***. Figure B-2 is for changing from a day schedule to a night schedule when night work ends ***before sunrise***. Figure B-3 shows how to transition from night duty back to daytime work.

Exposure to daylight (or exposure to bright artificial light of at least 1,000 lux) is a necessary input to set the body clock and keep it stable. These schedules show you when to seek exposure to daylight and when to avoid it. The figures assume that sunrise is at 0500 and sunset is at 2000. Of course, the real times for sunrise and sunset depend on geographical location and time of year, so modify these figures accordingly. The daylight symbol (*dl*) indicates the time range during which you should attempt to obtain daylight. Conversely, daylight-blocking symbols (*db*, daylight-blocking; *wb*, work with daylight-blocking; and *sb*, sleep with daylight-blocking) all denote times of day when daylight is present, but you want to avoid it by staying inside and keeping blinds/curtains closed. If you have to be outside (or on the ship's bridge) during these times, wear dark sunglasses (*sg*) to limit your exposure to bright sunlight. Pay close attention to the daylight and daylight-blocking symbols, as they change during duty hour transitions.

When you are on the night watch (for example, Days 4-6 in Fig. B.1), you want your body clock to be in a nighttime orientation. That means you must avoid any early-morning exposure to sunlight, because you want your body clock to think it's nighttime so you will be able to get to sleep. Avoidance of early-morning sunlight is particularly important to night workers--seeing daylight at the end of the night watch will reset the body clock back to a daytime orientation, making it hard to sleep during the day and making you more fatigued during your night watch. So wear dark sunglasses if sunrise occurs before you get off the night watch. Sleep periods (shown as *sb*, for "sleep with daylight blocking") start when you get off watch and go to early afternoon. When you arise in the afternoon, you want to seek exposure to daylight in order to set that time as the beginning of your "day." To promote exposure to daylight (during afternoons and evenings for those on night duty), you may want to schedule outdoor activities such as exercise or a walk outdoors. When naps are indicated, you should try to take a nap that is at least one to two hours long to compensate for the anticipated sleep debt. Try to follow the sleep and daylight management schedules as closely as possible.

In all three figures, your current work-rest schedule (the one you are on before you make the transition) should approximate the schedule shown as “Day 1.” During the first two days of transition to any nighttime duty schedule, reduce workload between 0400 and 0700 to prevent increased risk due to fatigue and sleepiness. During the transition back to day schedule, reduce workload near the end of the work period (after 1500).

Exposure to daylight periods must begin at the earliest time indicated in the time range and end at the latest time. Exposure to daylight should last as long as possible. Normal activities such as lunch and exercise should be scheduled to occur within the time range. Exposure to daylight is not required to occur continuously; however, two-hour exposures are recommended.

Let’s walk through the schedule shown in Figure B.1 as an example. Day 1 shows a normal daytime duty schedule. This person has been working in the daytime from 0700-1500 and has been sleeping at night from 2200 to about 0600 (0600-0700 would probably be showering, dressing, and eating breakfast). To begin the adaptation to upcoming night work, this person on Day 2 begins daylight blocking until about 1000, effectively delaying “sunrise” for the body clock. If the person is working indoors, the blinds would be drawn to block daylight; otherwise dark sunglasses would be worn until 1000. The sleep period would begin at 2200. Day 3 begins the nighttime duty. Daylight blocking would be used until 1000, at which time exposure to daylight is desirable. A nap of at least one hour is taken in early evening to help reduce sleepiness during the night watch. The night watch and collateral duties are shown from 2000 until about 0700. Note that work duties are occurring ***after sunrise***; this requires either daylight blocking (if working indoors) or the use of dark sunglasses to prevent exposure to daylight. Sleep, with daylight-blocking, occurs from 0700-1400. Upon arising in the afternoon, exposure to daylight (dl) is sought in order to help set the body clock to the nighttime orientation. Again, an early-evening nap is recommended to help reduce sleepiness while on the night watch.

Figure B.2 is very similar to B.1. The main difference is that in Figure B.2, the work period ends ***before sunrise***, so that daylight blocking during the work period is not necessary. The same major concepts apply: blocking daylight during the sleep period and getting exposure to daylight upon awaking in the afternoon.

Figure B.3 shows a person who has been on the night watch schedule and is transitioning back to a daytime watch. The important things to note are that on Day 2 there is an extended evening nap prior to the Day 3 midnight watch. To help adjust oneself to the upcoming daytime work schedule, exposure to daylight is desirable at

						sunrise														*sunset*				
	24	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Day 1	s	s	s	s	s	s	s	w	w	w	w	w	w	w	w								s	s
Day 2	s	s	s	s	s	sb	db	wb	wb	wb	w	w	w	w	w	w							s	s
Day 3	s	s	s	s	s	sb	db	db	db	db	dl	dl	dl	dl	dl	dl	dl	dl	n	dl	w	w	w	w
Day 4	w	w	w	w	w	sg	sg	sb	sb	sb	sb	sb	sb	sb	dl	dl	dl	dl	n	dl	w	w	w	w
Day 5	w	w	w	w	w	sg	sg	sb	sb	sb	sb	sb	sb	sb	dl	dl	dl	dl	n	dl	w	w	w	w
Day 6	w	w	w	w	w	sg	sg	sb	sb	sb	sb	sb	sb	sb	dl	dl	dl	dl	n	dl	w	w	w	w

Fig. B.1. Transition to night schedules when work ends after sunrise.

						sunrise														*sunset*				
	24	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Day 1	s	s	s	s	s	s	s	s	w	w	w	w	w	w	w								s	s
Day 2	s	s	s	s	s	sb	db	wb	wb	wb	w	w	w	w	w	w				n	n	n		
Day 3	w	w	w	w	w	sb	sb	sb	sb	sb	sb	sb	sb	dl	dl	dl	dl	dl	dl	dl	w	w	w	w
Day 4	w	w	w	w	w	sb	sb	sb	sb	sb	sb	sb	sb	dl	dl	dl	dl	dl	dl	dl	w	w	w	w
Day 5	w	w	w	w	w	sb	sb	sb	sb	sb	sb	sb	sb	dl	dl	dl	dl	dl	dl	dl	w	w	w	w
Day 6	w	w	w	w	w	sb	sb	sb	sb	sb	sb	sb	sb	dl	dl	dl	dl	dl	dl	dl	w	w	w	w
Day 7	w	w	w	w	w	sb	sb	sb	sb	sb	sb	sb	sb	dl	dl	dl	dl	dl	dl	dl	w	w	w	w

Fig. B.2. Transition to night schedules when work ends prior to sunrise.

Sleep (s)	Sleep with daylight blocking (sb)	Nap (n)	If possible, wear sunglasses (sg)
Work (w)*	Work with daylight blocking (wb)	Daylight Blocking (db)	Daylight exposure or artificial light exposure (dl)

*daylight exposure expected throughout daytime work hours

						sunrise														sunset			
	24	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Day 1	w	w	w	w	w	w	sb	sb	sb	sb	sb	sb	sb	sb	dl	dl	dl	dl	dl	dl	n	n	w	w
Day 2	w	w	w	w	w	wb	sb	sb	sb	sb	sb	sb	sb	sb	dl	dl	dl	dl	n	dl	n	n	n	n
Day 3	w	w	w	w	w	dl	dl	n	dl	dl	dl	dl	dl	dl	dl	dl	dl	dl	dl	dl			s	s
Day 4	s	s	s	s	s	s	dl	w	w	w	w	w	n	w	w	w	dl	dl	dl	dl			s	s
Day 5	s	s	s	s	s	s	dl	w	w	w	w	w	n	w	w	w	dl	dl	dl	dl			s	s
Day 6	s	s	s	s	s	s	dl	w	w	w	w	w	n	w	w	w	dl	dl	dl	dl				

Fig. B.3. Transition from nighttime to daytime schedules.

Sleep (s)	Sleep with daylight blocking (sb)	Nap (n)	If possible, wear sunglasses (sg)
Work (w)*	Work with daylight blocking (wb)	Daylight Blocking (db)	Daylight or artificial light exposure (dl)

*daylight exposure expected throughout daytime work hours sunrise and during the morning hours. At 2200 nighttime sleep is taken. Exposure to daylight is obtained as soon as possible after waking on Day 4, and the day watch is worked, with a ***short*** nap if needed (a long nap may prevent getting to sleep at night). Exposure to daylight in late afternoon and early evening help to reinforce the new day watch schedule for the body clock.